White Sands

Daniel Fry was a disappointed man on Independence Day 1950. He was then working for Aerojet Company and happened to be at White Sands, a lonely place in the emptiness of the desert and hardly the ideal spot to spend a national holiday-except for those who dislike crowds, of course. But as Daniel Fry had been seeing quite a lot of the Proving Ground on his job, it is hardly surprising that he should wish to go into the local center Las Cruces, some forty miles away, to see the fireworks-and to do some celebrating on his own. Unfortunately he had made a mistake about the bus times and missed the last one into the town. So he found himself in this lonely camp with hardly a soul to speak to. Never at a loss as to how he could make the best of a situation, Daniel Fry retired to his room and began to study a book on heat transfer.

There is an old saying that it never rains but it pours. It certainly was true in the case of Daniel Fry on this frustrating Fourth of July, 1950. At half-past seven something went wrong with the air conditioning system and the fans ceased operating. Poor Fry! Denied his celebrations, he was now even prevented from carrying on with his studies. But Fate had much in store for him, and perhaps it was preordained that he should remain in White Sands and not go to Las Cruces and that he should be forced to leave his room.

Daniel Fry decided that a walk was the only hope of finding somewhere cooler. He strode off down the bumpy road which led to El Paso in Texas, some sixty miles to the south and on the border with Mexico. However, he did not continue along this road for many minutes, but turned off westwards along a track that led to the flat land at the base of the Oregon Mountains.

He passed a rifle range and had walked some half a mile further when a strange thing happened. It was a night of brilliant starlight. There was a little light left in the west from the sunset and on the other side of the sky was the diffused light that comes just before moonrise. Yet in the rest of the sky countless millions of stars twinkled-some bright, some faint but all brighter than on an ordinary night. It was one of those nights when to look through the naked eye was like looking through the eyepieces of a pair of binoculars. Suddenly one of the brilliant stars went out!

Daniel Fry stopped in his tracks and stared. Whatever could it be? Stars are not in the habit of going out on a cloudless night. He wondered if it could be an aircraft. No. An aircraft might have obscured the light temporarily, but the star remained hidden. In any case he could hear no sound, and no aircraft are noiseless. It was so quiet in the desert that an aircraft could be heard when it was too far off to be seen. Was it a balloon? Hardly. Weather balloons are not sent up at night and never when their operators are on holiday. They do not remain still but rise rapidly, so any star they passed in front of would quickly appear again. While these thoughts flashed quickly through Fry's mind, another star went out! It was just to the right of the star that had disappeared at first. Then two more stars just below vanished. Whatever was the object that was cutting off the starlight seemed to be getting bigger every moment, and not only that, it seemed to be coming straight at Daniel Fry!

Suddenly he saw the object and realized why it had been invisible before. It was dark blue-black in color, almost the color of the night sky. This. naturally, made it very difficult to see, and only the outline could be discerned. At the same time Daniel Fry was aware of a strange feeling in his spine. He describes it as " a strong prickling sensation."

The object was moving towards Fry who, naturally, had the instinct to run away. However, his technical training and long experience in blasting and rocket work came to his aid. He had learned that it was foolish to run from an approaching missile until its trajectory is known and it is evident where it will strike the ground. Anyone speeding on foot can run into as well as away from a

missile's trajectory, and in any case it is not easy to judge the trajectory while running. So Daniel Fry stood still, rooted to the spot as he stared at the object now so near to him.

It seemed about thirty feet across at the widest part. He judged it to be travelling at about fifteen or twenty miles an hour, but it was losing speed rapidly and he reckoned that it would be motionless by the time it touched the ground. He saw too, that the spot where it would reach earth was some fifty feet from where he stood -unless it changed course-and he was very glad he had not attempted to run away. Wonderingly he stared at it as it glided as lightly and as silently as a piece of thistledown to settle on the ground some seventy feet away-somewhat further off than Fry's first estimate. It made a slight crunching sound as it crushed the undergrowth beneath it--otherwise it was silent. Daniel Fry stood stock still and gaped at the craft-just as a child at his first circus performance stares at those in the ring.

A confused jumble of thoughts rushed through Fry's mind. What could this be? Of all the different spheres of life, Fry worked in an occupation where he came in contact with the latest types of aircraft and rockets. He, more than anyone else, would be in a position to recognise the most recent model. even if a closely guarded secret. His first reaction was " If the Russians have ships like this, God help America." But speedily came the comforting thought that this mysterious craft could not be from Russia or from anywhere else on Earth for that matter. Whoever had built this craft had solved a lot of problems whose existence our best physicists are only just beginning to realise.

The Space Ship's silence mystified Fry more than anything else. There had been no thrumming propellers, no flash and roar as burning gases were hurled from nozzles to produce thrust. The Space Ship had simply coasted in from the vastness of Space and settled gently on Earth. Perhaps that was the explanation-perhaps its engines had been cut off when still many miles above Earth. Fry had only seen it gliding down, but it had slowed down before coming to rest, and didn't seem to be falling. Only a helicopter or a lighter-than air craft could do this. It was certainly no helicopter, as he could see no propeller blades or rotors, neither could it be lighter than air as its weight had crushed the scrub beneath it when it landed. It was certainly able to defy Sir Isaac Newton's law of gravity. Here again we have convincing proof of the veracity of Daniel Fry's story. Nearly all reports of Flying Saucers tell of their ability to neutralise and even reverse the gravitational force in order to move.

Daniel Fry's meditations were interrupted with a start when he woke up to the fact that he was unconsciously walking towards the craft. He does not claim to be a hero, and every instinct and thought in him urged him to put as much distance as possible between himself and the unknown and therefore unpredictable object. However, Daniel Fry was blessed with a quality that is essential to the true scientist curiosity, and when the object which arouses it is of a scientific nature-especially if it be of an important advance in knowledge, this curiosity became a mania which swept all other emotion from its path.

So Fry walked up to within a few feet of the craft and began to walk slowly round it, eagerly drinking in the detail, and his expert mind puzzled as to the many unusual features of the Space Ship. As it had appeared from the air, it was oval shaped, flattened at the top and bottom, making the maximum height some sixteen feet, while the greatest width was about thirty feet, the widest point being about seven feet above the ground. If looked at from below, at an angle of less than forty-five degrees from the vertical, it might seem to be saucer shaped ; however in actual fact it was more like an inverted soup bowl over a sauce dish. No longer did the craft appear dark blue as it had done at first. Fry realised that it was then merely reflecting the colour of the sky. It was in fact a silver colour-the reflection of a polished metal surface. In addition to this there was a very slight violet iridescence. Although Fry walked all round the Space Ship, he could see no sign of any opening or seam. He thought that anyone inside would get out either through the top or the bottom.

This craft comes into the category of a scout ship or Sampling Craft, so we will give it this name from now on. But we shall see as we go along that in some respects the craft was very different from the ordinary manned Sampling Craft with a crew of three or four.

Daniel Fry paused to take stock of the situation. What to do next? Should he return to his camp and report the Sampling Craft? At first this seemed the obvious thing to do, until the realisation dawned on Fry that it would take at least three-quarters of an hour to get back to the camp, find someone in authority, and return with other observers. By that time the Space Ship might easily have taken off, leaving only the crumpled patch of brushwood to show that Fry had been telling the truth. Who would believe such an unlikely tale on such slender evidence? And if he did, would he dare admit it? He knew only too well of the merciless ridicule poured by the scoffers and determined sceptics on those who had been incautious enough even to admit they had seen mysterious objects in the sky. How much worse would be the hooting laughter and jeering comments at anyone who had actually claimed to see one land and been close enough to touch it-yet had no evidence other than a flattened patch of brush! Daniel Fry suddenly realised that although he had been close enough to the craft to touch it, he had not actually done so as yet. He wondered if touching it would help him to get some idea of what the Sampling Craft was made of. The feel of the material might offer some clue as to its nature. In any case he could see how hot it was. So Fry stepped forward and gingerly placed a finger tip on the polished metal. No, he didn't feel any sensation of burning, the metal was not even hot. It was merely a few degrees warmer than the air. But the most remarkable thing was its smoothness, a smoothness difficult to describe. Anyone running their finger over a large pearl which had been covered with a thin soap film might feel the same sensation as Daniel Fry felt when he touched the metal surface of the Sampling Craft. Fry stroked the metal with the palm of his hand. He felt a slight but definite tingling in his finger tips and the wrist end of his palm.

"Better not touch the hull, pal, it's still hot." A crisp voice came out of the air beside Daniel Fry and suddenly shattered the silence of the balmy summer night.

The Voice Without a Body

DANIEL FRY STARTED as though he had been shot, and catching his foot against a root went flying full length in the sand. This incident does not sound as if it were made up. Hoaxers are too conceited ever to admit having been taken aback.

What sounded like a chuckle was definitely audible as Fry lay on the ground, then the voice came again, its tone much more friendly. “Take it easy, pal, you are among friends." However Daniel Fry felt far from taking things easy. The sudden humiliation of tripping up and resultant pain as he struck the ground, the familiar English language and the tone, not in the least hostile, in which the words were spoken, had driven all fear away. Instead Fry felt irritated.

"You could have turned the volume down," he grumbled. " You didn't have to blast out at me like that. You scared me out of a week's growth."

"Blast out?" the voice hesitated, evidently unfamiliar with American slang. "Oh yes, you mean the amplitude of the warning was too great. Sorry, buddy, but you were about to kill yourself, and there wasn't time to diddle with the controls."

"You mean that the hull is highly radioactive," Fry asked, drawing back instinctively. "If so, I am still much too close."

"It isn't radioactive," came the reply. "I used the term 'hot' because it was the best I could think of in your language to explain the condition. The hull has a field about it which repels all other matter.

The field is very powerful at molecular distances but diminishes by the seventh power of the distance so that the force becomes negligible a few microns away from the hull. Perhaps you noticed that the surface seemed very smooth and slippery. That is because your flesh did not actually touch the metal, but was held a short distance from the surface by the repulsion of the field. We use the field to protect the hull from being scratched or damaged in landing. It also lowers air friction tremendously when it is necessary to travel at high speed through an atmosphere."

"But how would this kill me?" Fry asked, wonderingly. "I did not touch the hull and felt only a slight tingle in my hand, and what did you mean by that crack about my language? If you aren't an American, I've never heard one."

"As to your first question " the voice went on imperturbably, its calmness in strong contrast to the excited Fry, "it wouldn't have killed you at once. In fact it might have taken several months, but it would have been just as certain as if it had been instantaneous. The best way that I can explain it to you is to say that exposure of the human skin to the force field causes the skin to produce what you call ' antibodies' in the blood stream. For some reason which we don't yet fully understand, these antibodies are absorbed by the liver, whose function they attack causing the liver to become greatly enlarged and congested. In cases where the skin is exposed to the field for a minute or more, death is practically certain. In your case I don't think you have been exposed long enough to be in any great danger; although you will undoubtedly feel some effects sooner or later, provided, of course, that your biological functions are identical with ours, and we have every reason to believe they are.

"As to your second question I am not an American, although my present assignment requires me to become one. The fact that you believed me to be one of your countrymen is a testimonial to the success of the effort I have expended during the last two of your years to learn and practise the use of your language and idiom. As a matter of fact, I have never yet set foot on your planet. It will require at least four more of your years for me to become adapted to your atmosphere and gravity and to become immunised to your biotics."

The voice stopped. In the ensuing silence Daniel Fry stood still for what seemed to him a very long time, but which in actual fact was probably only a few seconds, trying to take in the full meaning and implication of what he had heard. Eventually he said slowly, "If I had not with my own eyes seen this craft come in and land, I would have said that you were some nut who had been reading too many 'Science Fiction' stories. As it is, I am prepared to admit the possibility of almost anything. Besides, since my being here and seeing you land was entirely accidental, it is obvious that my belief or disbelief could not be of the slightest importance to you."

"On the contrary," came the voice again, when Fry had finished speaking. "It is important to us that you be given every opportunity to acquaint yourself with the facts and to form your own opinion accordingly. One of the principal purposes of this expedition is to determine the basic adaptability of the Earth race, particularly the degree of their ability to adapt their minds quickly and calmly to conceptions which are completely foreign to their customary modes of thought. Previous expeditions by our ancestors met with almost total failure in this respect. This time there is hope that we may be able to find minds sufficiently receptive so that we may be of some assistance in the progress of your race. In your case, at least up to the present moment, your conduct has surpassed our best expectations."

"I can see," retorted Fry, "that your race, whatever it is, and ours have at least one thing in common that sarcasm is the principal form of humour. However, you can't annoy me that way. I have been kidded by experts.

"I realise that everything I have done since you came into sight has been wrong. In the first place, if I had any sense, I would have got out of here fast when I first saw you coming, instead of waiting, perhaps, to be crushed under the ship.

When you landed, instead of leaving, or at least remaining at a comparatively safe distance, I had to come snooping around your craft. Then, when your warning voice came through your speaker or whatever it is-instead of accepting the warning calmly and quickly, I jumped like a scared rabbit and landed in the sand in about as undignified a position as it is possible to imagine. Last, but not least, you apparently suppose that I believe the statements which you have made. As I said before, I am prepared to consider the possibility that they are a lot of 'hooey'."

"Precisely." replied the voice. "Let me explain my position. No sarcasm was intended. I meant exactly what I said. In the first place you said that curiosity impelled you to investigate the craft, subjecting yourself to unknown hazards rather than to seek safety in flight. This typifies the struggle between the desire for knowledge and the desire for the safety of the *status quo*. I believe that there is an old saying among your people that self-preservation is the first law of nature. It is encouraging to note that the desire for knowledge can occasionally overcome the animal instinct. When I called a warning to you, your reaction was not one of fear as you seemed to think. A reaction of pure fear would have frozen you into immobility at least for a moment. Instead, you acted instantly and in the proper manner. The fact that you stumbled merely indicates that your concentration on tile details of the ship' was so great that you failed to maintain a clear avenue of retreat.

"As for believing is what I say, merely because I say it, that is the last thing which we desire. What we need are minds sufficiently open to receive evidence (even though that evidence be contrary to all preconceived opinion) and minds sufficiently agile to assimilate that evidence and arrive at logical conclusions. The fact that, in spite of being in circumstances completely unique in your experience, you are listening calmly to my voice and making logical replies, is the best evidence that' your mind is the type we hoped to discover."

And it is also the best evidence that Daniel Fry did not invent the story. Apart from the undergraduate, which Fry was not, the hoaxer is usually a man whose intelligence is not very high. Because of this he has not the knowledge enjoyed by the man better equipped with brains. Ignorant men panic in the face of the unknown. Not so Daniel Fry. We can see once again how this tale rings true-men of another planet would naturally wish first to get in touch with a technician or scientist people whose intelligence would enable conversation with those in the Space craft to be carried on at a much higher level than with ordinary folk and whose curiosity would be greater than their fear.

"Thanks for the compliments." replied Fry, less hostile now. " I wish I could believe that I deserved them, but your statement implied that you propose to use me in some project which involves the scientific advancement of the people of Earth. Why pick me? Just because by the merest accident I happened to be here when you landed. I could easily put you in touch with any one of dozens of men right here at the base, who are far more advanced than I in science."

"When you say that you happen to be here by the merest accident, you greatly underestimate us," was the unseen voice's reply. "The brains of many Earth men transmit readily, but you are one of the very few whose brain also receives well. If you inquire: when you return to your quarters, you will discover that the air conditioning system did not break down tonight ; although it has frequently clone so in the past. But to get back to the subject of discussion, we have investigated the minds of many of your top scientists. In every case we found that their minds had hardened into the mould of their present conceptions. They have advanced too far. Consequently they would have too far to retreat. I can make my meaning plainer by an analogy. A man seeking scientific knowledge is like an ant climbing a tree. He knows when he is moving upward, but his vision is too short to

encompass the entire trunk. The result is that he is likely to get out on a lower limb without realising that he has left the main trunk. All goes well for a time. He can still climb upward and even pluck a few of the fruits of his progress, but soon he begins to become confused as the solid branch suddenly begins to break up into myriads of twigs and leaves all pointing in different directions.

"So the seeker of knowledge finds that the great 'Basic Laws' which have always been so unshakeable. now begin to divide and to point in opposite directions. The scientist comes to the conclusion that he is nearing the limit of the knowledge which can be conceived by the mind and that all physical laws ultimately become purely statistical. When he has reached this point he can make further progress only by following a line of abstract mathematical reasoning. This is like travelling on a train in one of your underground railways. You will probably eventually arrive at your destination. but since you cannot see where you are going along the way, you have no way of being sure that there was not a much shorter and easier way to get to the same place. Your science is now in this position. For example, your scientist is now obliged to state that the electron is at the same time both a particle and a wave motion. They attempt to rationalise this by saying that the electron is a particle in a wave of probability. This is a condition which cannot be visualised by the mind and the only means of progress are through the subways of abstract mathematics.

"The fundamental truths are always simple and understandable when viewed from the proper perspective. So the branch becomes simple and understandable as a 'branch' when viewed from above on the main trunk. In short, what your science must do if it is to continue to progress is go back down the limb on which you are trapped to the point where it joins the main trunk and then start up again. This we can and will help your people to do, but only if they wish it and are able to follow the path which we will point out. This, however, is for the future. Before we can be of any assistance to the people of the Earth, two things must be accomplished. First: Our bodies must become biologically adapted to your environment, so that when we come among you we will be identical with your people. This as I said before will require at least four more years. The second condition is more difficult. The political tensions which now exist between your nations must be cased. If either of the two dominant nations of Earth were to achieve conclusive scientific superiority over the other, under present conditions a war of extermination would be certain to follow. We are not here to assist any nation in making war but to stimulate a degree of progress which will eliminate the reasons for wars on Earth. even as we, some thousands of years ago, eliminated the reasons for conflict among our own people. But I see you are becoming weary of standing out there in the sand and listening to these dissertations on science and sociology.

“This reminds me of my duties as a host. Would you like to enter the ship and perhaps make a short flight? It is only a cargo carrier with remote control, but it does have a small passenger compartment with several seats which are plain but quite comfortable."

"I would be very glad to be allowed to see the inside of the ship," Fry replied with enthusiasm. " I would give anything to be allowed to ride in it, but how can I get in? I have been completely around the ship and saw no sign of an opening. Also you said you are not yet accustomed to our atmosphere. If I come in I will have to bring my atmosphere with me. How will that affect you?"

"As I said before," replied the voice. "the craft is a remote controlled cargo carrier. Some of you Earth people would call it a Sampling Craft. I am not in this craft. I am in the central, or what you would call the mother ship or mothership which is at present some nine hundred miles above the surface of your planet. This cargo craft is being used to bring us samples of your atmosphere so that we can accustom ourselves to it. The atmosphere so that we can accustom ourselves to it. The cargo hold is evacuated so that when I open the intake port the hole becomes filled with atmosphere at whatever temperature and pressure exists there. Also any bacteria which are in the air are brought

along for study and for the production of anti-toxins. The intake port is on the top of the craft. I will open it now."

Daniel Fry heard a sound, partly a hiss and partly a murmur, which came from the top of the Sampling Craft. It lasted for about fifteen seconds. He was surprised at the small volume of the sound. Any port large enough to have filled a craft that size with air in fifteen seconds should have produced quite a roar. Then he realised that the hull was almost, if not entirely, sound-proof, and since most of the sound of the entering air would have been produced inside the hull very little would be audible outside.

Again Fry heard a sound from the surface of the Sampling Craft, this time. a small but sharp click such as might have come from the operation of a single-arm relay or a small solenoid and a portion of the hull lust to his left moved back upon itself for a distance of several inches and then moved sideways, disappearing into the wall of the hull, leaving an oval shaped opening about. five feet in height and three feet wide. Fry moved over to the port or hatch, whichever it might be called and ducking his head slightly, advanced into the opening. Because of the curvature of the hull his head was inside the craft while his feet were still on the ground.

The compartment into which Fry was looking occupied only a small portion of the ship's volume. It was a room about nine feet long and seven feet wide, with the floor about sixteen inches above the ground and the ceiling slightly over six feet above the floor. The walls were slightly curved and the intersections of the walls were beveled so that there were no sharp angles or corners, of course, the wall nearest to him, through which the opening led, was the hull itself and had the same curvature inside and out. This wall was about four inches thick and it was into this wall that the door or hatch had been drawn. The room contained four seats which looked much like our modern " body contour chairs" except that they were somewhat smaller than the ones to which we are accustomed. The seats were facing the opening in which Fry was standing and were arranged in two rows of two each in the centre of the room, leaving an aisle between the seats and either wall.

In the centre of the rear wall, where it joined the ceiling, there was a box or cabinet with a tube and lens which resembled a small moving picture projector, except that there were no visible film spools or any other moving parts. Light was coming from this lens. It was not a beam of light such as would come from a moving picture projector but a diffused glow which, while it did not seem especially bright still furnished enough light to see comfortably.

The seats and the light seemed to be the only furnishings in the otherwise bare metal room. "Not a very inviting cabin," Fry thought. "Looks more like a cell."

"As I said before, it's plain, but you'll find the seat comfortable," said the voice again. Fry started at the reading of his thoughts. "Step in and take a seat if you wish to ride. We haven't too much time."

Almost automatically Fry stepped up on to the floor of the cabin and started for one of the seats. Before he reached it, he heard a click as the door began to slide out of its recess in the wall behind him. Instinctively, he half turned as though to leap out to the comparative safety of the open desert behind him, but the door was already closed. If this were a trap, he was in it now and there was no use struggling against the inevitable.

"Where would you like to go?" came the voice again and this time it did not seem to be coming from beside Fry but rather from inside him as though he were hearing words which he himself were speaking.

"I don't know how far you can take me in the time you have," he replied. "And since this compartment has no windows, it won't matter which way we go, as I won't be able to see anything."

"You will be able to see," was the reply. "At least as much as you could see from any vehicle in the air at night. If you would like a suggestion, we can take you to New York City and return you here in about thirty minutes. The light pattern of large cities at night from about twenty miles up has always been to us one of the most impressive sights to be seen on your planet."

To New York

DANIEL FRY WAS amazed. Such speeds seemed fantastic.* "To New York - and back - in thirty minutes!" he said slowly. "That's eight thousand miles per hour! How can you produce energies of that order on a craft like this, and how can I stand the acceleration? You don't even have seat belts on these seats!"

"You won't feel any ill effects from the acceleration," was the reply. "In fact, you won't feel the acceleration at all. Just take a seat, and I will start the craft. I will explain some of the things which puzzle you during the ride."

Fry sat down in the left front seat which was the one nearest the door and found that it was indeed very comfortable. The material of which it was made felt like foam rubber with a plastic covering. However, there were no seams or joints such as an outer covering would require, so the material, whatever it was, had probably been molded into its frame in a single operation.

Then the voice broke into Fry's thoughts again. "I will now turn off the compartment light and turn on the viewing beam."

For a moment the room became utterly dark. Then the projector again became active. This time it was not a diffused glow, but a beam-just as in a movie or slide projector. The beam, or that part of it which was visible at all, was a deep violet, at the very top of the visible spectrum. The beam spread over the door, through which Fry had come, and the door disappeared. It did not slide back into the wall as it had before. It simply ceased to exist, at least visually. It was as though he were looking through the finest type of plate glass window.

"There isn't time to give you a complete understanding of all the things which you would like to know about this craft and about us, but perhaps I can explain a few of the basic principles about which you seem to be curious." the voice said-or rather Fry's voice said-for he was just beginning to realise that the words which lie had been hearing were not corning to his ears as sound waves at all but rather were originating directly in his brain.

"The door as you see, has become transparent. This startles you. because you are accustomed to thinking of metals as being completely opaque. However, ordinary glass is just as dense as many metals and harder than most and yet transmits light quite readily. The beam of energy, which is now acting on the metal of the door, is what you would call a frequency multiplier. The beam penetrates the metal and acts upon any light that reaches it in such a way that the frequency of the light is multiplied to that of the range between what you know as the 'X-ray' and the 'Cosmic Ray' spectrums. At these frequencies the waves pass through the metal quite readily. Then, when these waves leave the metal on the inside of the door, they again interact with the viewing beam, producing what you would call 'beat ' frequencies which are identical with the original frequencies of the light, so that while you are apparently seeing through the metal you are actually seeing a reproduction. If you are ready I will now start the craft."

Instinctively, Fry braced himself in the seat and gripped the sides with his hands. A moment later, the ground suddenly fell away from the ship with incredible rapidity. When I write that the ground " fell away " I say so because Fry did not feel the slightest sense of motion himself. and the ship was as steady as a rock. In spite of the fact that they must have been accelerating at the rate of at least ten g's, he could have sworn that they were standing still.

The lights of the army base at the Proving Grounds, which had been hidden by a small hill, sprang into sight instantly and began drawing together like a flock of baby chicks when called by the mother hen. A few seconds later the lights of the town of Las Cruces came into view in the lower left hand corner of the window, and Fry knew that the Sampling Craft had risen at least a thousand feet in those two or three seconds. The ship was rotating slightly to his left as it rose, and he was also able to see the highway from Las Cruces to El Paso, a very narrow but brilliant ribbon illuminated by the headlights of the thousands of cars that were upon it. The lights of El Paso and Ciudad Juarez were just a solid glow on the horizon, but as the craft continued to rise, they seemed to draw nearer and to break up into patches of varied brilliancy. Fry could see the patch which represented the Presidio area, the hundreds of thousands of lights of Fort Bliss, and the intensely bright spot which was downtown El Paso. He even imagined that he could distinguish the thin dark line which was the Rio Grande separating El Paso from its Mexican twin, Ciudad Juarez. A few more seconds and the ship had rotated until the lights of these cities passed out of view on the right hand edge of the viewing screen.

The viewing screen was now pointed south-east and had stopped revolving. The surface of the earth now appeared to be glowing with a slightly greenish phosphorescence. At the same time, the sky outside of the ship had become much darker, and the stars seemed to have doubled in brilliance.

"We must have entered the stratosphere," Fry thought to himself. "If so, we must have risen more than ten miles in what can't have been more than fifteen or twenty seconds, yet I have not felt the slightest sensation of acceleration."

"You are now about thirteen miles above the surface." Once more Fry started when the voice answered his unspoken thought. "And you are rising at approximately one-half mile per second. We have brought you up rather slowly so that you could have a better opportunity to view your local cities from the air. We will take you up to thirty-five miles for the horizontal flight. At that level the residual atmosphere is attenuated to a degree which offers no appreciable resistance to the motion of the craft."

"By the way," Fry asked. "what happened to the Moon? It was just coming up when I entered your ship and it must be somewhere in the sky, but everything looks so dark outside."

"It looks dark," was the reply, "simply because there is not sufficient atmosphere at this level to diffuse the light. You would not see any evidence of the moonlight unless it were shining directly on the viewing screen. I have purposely kept the craft from rotating far enough for this to happen, as the light is quite intense above the atmosphere, and it would be difficult, if not impossible to see anything else while it was visible. You are now high enough that I can begin to add a substantial horizontal component to your vertical motion.

"Since there will be little of interest to see during the next few minutes, I will take this time to explain a few of the things that puzzle you. In the first place, you mentioned something about 'seat belts ' and questioned whether you could endure the acceleration, This is a question which seems to have come up quite frequently in the minds of the men of science on your planet.

"Whenever our vehicles have been observed by any of your people, and when the velocities and accelerations of these craft are described, disbelief is always apparent. We have heard some of your

most learned men make the statement that: ‘No human being or other higher form of life, as we know it, could survive acceleration of this order.' This has always been a matter of disappointment to us in our evaluation of the intelligence of the people of Earth. It seems to us that even a moderately intelligent layman with the average knowledge which your people possess should be able to refute this statement at once. The answer is, of course, simply that the force which accelerates the vehicle, acts not only upon every atom of the vehicle itself but also acts equally upon every atom of mass which is within it, including the pilot or passengers.

"In your aeroplane the situation is entirely different. You have propellors or jets, which produce a thrust upon one part of the ship. This local thrust accelerates the ship, but not the pilot. The pilot is accelerated only by thrust against those parts of his body which are in contact with the seat. Because of the inertia of the remainder of the body, compression is produced which causes the feeling of acceleration, or in extreme cases, blackout or actual crushing of the body. Our only limit of acceleration is the limit of available force."

"But in this case," Fry reflected. "why am I not floating around in the air as things are supposed to do within a missile which is in free fall?"

"The answer to this also should be fairly obvious," came the voice's reply. "Before the ship was put into motion, you were resting upon the seat, and there was a force of one gravity acting between your body and the seat. Since the force which accelerates both the ship and your body acts in exact proportion to the mass, and since the Earth's gravity continues to act upon both. the original force between your body and the seat will remain constant, except that it will decrease as the force of gravity of the planet decreases with distance.

"When travelling between planetary bodies, far from any source of natural gravity, we find it necessary, for practical reasons, to reproduce this force artificially. The gravity to which we are accustomed is but little more than one-half of that which exists upon the Earth. This is the principal reason that it will take so much time for us to become ordinary members of your race. If we were to land now upon the surface of your planet and leave the protection of our ships. the high gravitational force would put a severe strain upon our internal organs, which in a few days would produce serious illness, and eventually death.

"This is not merely calculation. We know it to be true because it has been tried several times in the past. By remaining in our ships where we can control the force to which we are subjected, and by increasing that- force by small but regular increments, we can build up the supporting tissues and strengthen our muscular systems until, eventually, your gravity will become as natural to us as our own is now.

"When this time comes, it is our hope that you and a few other members of your race, who have retained sufficiently open minds, will be able to assist us in bridging the considerable gulf which exists between our culture and yours. However, as I have said before, we will never attempt to force either our knowledge or our culture upon you and will never come to your people unless there is substantial evidence that they desire it.

"It is true that the purpose of this expedition is not entirely philanthropic. There are some materials upon your planet which we could use to the advantage of both our peoples, material which you have in great abundance but which are rather scarce elsewhere in this solar system. While we desire the use of these materials, our service to your people will not be made contingent upon such use. Any knowledge or assistance which we can give will be freely offered."

"Could you explain to me the principles of operation of this craft?" Fry asked. "How do you produce the tremendous amounts of energy necessary to accelerate a ship like this to such high velocities, and how do you apply that energy without producing any outward evidence of its application?"

"In order to do this," was the reply, "I would have to give you an entirely new groundwork in Basic Physics. As I said before, your science is attempting to make one lower limb take the place of the entire tree of knowledge, with the result that your science has become greatly overcomplicated. Then, when this science is applied to practical ends, the resulting apparatus becomes prohibitively complex. For example, certain engineers and scientists of your country are now engaged in planning a submarine to be driven by what you call atomic or nuclear energy.* They plan to do this by constructing a 'pile' in which the lighter isotope of uranium fissions producing heat energy and free neutrons which are absorbed by the heavier isotope of uranium converting it into the next heavier element in the transuranic series which also, in turn, is fissionable. This method, while rather complicated, is still the most potent source of energy differential which your people have yet produced, but in order to convert this heat energy into propulsion of the ship, they plan to circulate a working fluid through the 'pile' to absorb the heat; circulate the 'working fluid' through a heat exchanger to convert another fluid to vapour under pressure, pass the vapour through a turbine to produce torque and, finally, use the turbine to drive a generator to produce an electrical current. If they achieve an overall efficiency of thirty per cent it will be a great feat of engineering.

"If they were capable of thinking in simpler terms, they could. with the knowledge which they now possess, construct a simple thermopile about the fission pile and convert the resulting temperature gradient directly into electric energy with an efficiency of at least ninety-four to ninety-eight per cent, with no moving parts, at a smaller cost, and considerably less mass per unit of energy output. Compared with our methods, even this system would seem wastefully complex.

"Your greatest need is to discover the utter simplicity of the basic laws or facts of nature. Then you will easily be able to produce effects which now seem to you to be impossible.

"When your engineers design a vehicle for transportation of freight or passengers, they feel it necessary to provide a means of producing an energy differential within the vehicle itself as a motive power. Yet your ancestors, for thousands of years travelled to all parts of your planet in ships which had no internal energy source but which were operated entirely by the kinetic energy of the atmosphere. While this was not always a reliable source, it was sufficiently successful that it should have made your people realise that there are many types of energy differential constantly available and it is only necessary to design a means whereby the flow of energy can be made to produce the desired result.

"One of the principal obstacles to the rapid progress of your science is that your scientists have not yet fully grasped the simple unity of matter and energy. One of your greatest thinkers, a professor, Albert Einstein, published, many years ago, the mathematical formula which described quantitatively the equivalence of matter and energy. This formula, while perfectly correct mathematically, leads to the incorrect conclusion that matter is convertible into energy and vice versa. The truth is that matter and energy are merely different aspects of the same entity.

"Consider a geometric plane surface having two dimensions. If this plane is perpendicular to your line of sight you perceive it as a plane surface. This represents the matter aspect of the entity. If now you rotate the plane through an angle of ninety degrees, the surface will disappear from your sight. leaving only one dimension. This is the energy aspect of the entity. You have not changed the plane in any way. You have merely changed your point of view, or technically you have changed your point of reference.

"The amount of energy which is apparently contained by a given body of matter depends entirely upon how far it has rotated upon the mass-energy axis with respect to the given observer. Another observer, observing the same body from a different reference point, would find an entirely different amount of energy contained.

"Assume that we have an observer upon each of two planets which are travelling through Space at, say, half the speed of light, but which are travelling at exactly the same speed and upon parallel courses. If no other bodies of matter existed in the Universe, the observers would inevitably come to the conclusion that their respective planets had no kinetic energy, since the only reference points available are at the same energy level. If we now postulate a third planet, and assume that it is at rest in Space, both observers will note that. while their respective planets have no kinetic energy relative to each other, they both have a very high energy with respect to the third body. There would still be no means of determining which of the bodies were actually moving. It could only be determined that there was a relative motion or an energy differential between them.

"Another clue which your Dr. Einstein brought to light through abstract mathematical reasoning was that, as a body of matter increases in velocity, its dimension decreases in the direction of motion. When the body reaches the velocity of light, it ceases to have any dimension in the direction of motion. This, of course, is because it has rotated upon the mass energy axis, relative to that observer, until it has ceased to be matter and has become pure energy. Thus you will see that it requires 9×10^{20} ergs of energy to accelerate one gram of mass to the speed of light. Since at this velocity it ceases to be matter, it is obvious that no amount of energy could further increase its velocity with respect to the given reference point.

"However, there will be time enough for further discussions of physics later. Since this is principally a sight-seeing tour, I should be pointing out the sights to you.

"The large city to the north of you is Saint Louis, and the glow on the horizon dead ahead is Cincinnati. You will be over it in less than two minutes, and soon after you will be able to see the lights of Pittsburg.

"You see that we have learned a great deal of your geography as well as your language. Your history is not so well known to us, since your race does not think much in terms of the past. Of course the history of the original civilisations are much better known to us than to your race."

This last statement did not register on Fry's consciousness at the time, as he was engrossed in watching the lights of Cincinnati swimming silently toward him on the Earth's surface thirty-five miles below.

Due to their eastward travel, he knew that the Moon must be almost directly overhead, but the surface of the Earth gave little evidence of its reflected light. The greenish phosphorescence which he had seen when rising in New Mexico, had almost disappeared. He had never heard any estimate of the Earth's albedo,* but, judging from its almost total darkness at this level, he thought that the reflectivity of the land areas at least, must be very low. Of course it was only moonlight he was judging by, and he was not nearly far enough from the Earth's surface to form any true estimate of the albedo.

The lights of Cincinnati were almost underneath Fry now. There were too many lights, and they were too close together to distinguish many of them individually. The general effect was that of looking down upon a bonfire, which had burned down to a bed of bright coals, with a few much brighter points which flashed and sparkled like rhinestones in a spotlight.

Of course Cincinnati was not the only city visible from this point. At an altitude of thirty-five miles the line of sight becomes very long, and even in the restricted area of the viewing screen, he could see, at any one time, literally hundreds of various size "embers," sparkles and pin-points of light, all representing human habitations, enterprises, or guiding beacons.

"You will be over New York City in a few minutes," Fry heard the voice inside hire say. "And I am going to begin to bring you down to the twenty mile level. Since the craft in which you are riding was not designed to carry passengers (the passenger compartment being only an emergency provision) it was not considered necessary to provide complete negative gravity compensation such as we have in all of our larger ships. Consequently, as you start downward, you will be accelerating in the direction of your own gravity, so that your body weight will become somewhat less. If this becomes distressing to you I will lower the rate of acceleration."

Fry felt a mild lifting of stomach, such as one feels when starting down in rather a slow elevator, except that in this case the sensation persisted for about thirty seconds. Then his weight became normal again." You are now moving downward at a constant rate which will bring you to the proper level in another minute. The levelling off process, of course, involves positive gravity acceleration, so you will not feel it. You did not seem to be greatly disturbed by the gravity change, but since your race has not yet developed gravity compensation devices for your transportation vehicles, I suppose that you may be more inured to such changes than we."

"If you think that I should be distressed by a change as mild as that," Fry replied laughing, " you should try riding one of our roller coasters or doing an 'outside loop ' in one of our ' squirt jobs '"

"Just a moment," the voice sounded puzzled. "I am afraid that you have me at a disadvantage. I had flattered myself that my understanding of your language was practically perfect. Yet you have just used two terms whose meaning is unknown to me. Would you please explain them or give me synonyms?"

"You mean ‘roller coaster' and 'squirt job '?" Fry asked. "The roller coaster is a mechanical device found in many of our amusement parks. It consists of a low open car with seats for passengers and equipped with hand rails for the rider to grip. It has steel wheels which roll upon a pair of steel tracks laid upon an elevated framework. When the passengers have taken their seats, the car is connected to a moving chain between the tracks, which tows the car to the highest point in the structure. There the car is released from the chain and gravity is allowed to take over. The tracks dip downward at a very sharp angle, until they reach the ground level and then again rise sharply almost to the level of the starting point. These sudden climbs and drops are repeated a number of times, and there are several steeply banked short radius turns so that the track is circular, and at the conclusion of the ride the passengers have been returned to their point of departure, and the car is ready for another load of thrill seekers.

"The feeling of exhilaration produced by the ride is caused by the fact that the reflex portion of the brain, upon sensing the rapid change of gravity, causes adrenalin to be released into the blood stream. This, of course, occurs whenever the body is confronted by sudden peril, but in this case, the rider knows that there is no real danger. So he is able to enjoy the stimulation produced by the adrenalin without being subject to any actual hazard.

"A 'squirt job ' is a term in American 'slanguage ' which refers to one of our jet propelled aircraft. I presume that you are fully familiar with these since you should have had ample opportunity to study them. An 'outside loop' is a manoeuvre in which the aircraft describes a circle in a vertical plane with the upper side of the craft remaining at the outer periphery of the circle."

"Thank you," replied Fry's host. "I know now that we made no mistake when we chose you as a means of direct contact.

"You are now on the twenty mile level, and your city of New York lies before you. The craft is approaching it from the north-west side and will continue on this course until it reaches the ocean at the north-east extremity of the city. It will then circle the city until it is travelling westward. At the same time the craft will rotate so that the viewing screen will always be toward the centre of the city. Your velocity has been reduced to about six hundred miles per hour so that you will have more time to enjoy the view."

Fry looked out of the Sampling Craft, or rather looked on the door screen at the wonderful sight spread out before him. He wished he were a writer so he could find suitable words to describe the wonderful sight below him. He peered down at the greatest city in the Western Hemisphere and was thrilled.

At the twenty mile level the lights were much brighter and had greater individuality than they had seemed to have from the higher level. This was no glowing bed of coals with a few brighter sparks but a vast array of millions of blue white diamonds, scintillating and coruscating against a black velvet background. The differing temperatures of the various air strata beneath the Sampling Craft, combined with its rapid motion, caused the lights to twinkle violently, so that the entire city was a sea of pulsing, shimmering luminescence. "If I were an artist," thought Fry, " this would probably be the greatest moment of my life, but my hunger for knowledge must greatly exceed my appreciation of purely aesthetic values. Beautiful as this scene is and interesting as the ride has been, I would gladly have traded it all for a five minute tour of the mothership or mother ship."

"We regret that there was not enough time to arrange such a tour," was the reply. "But you will remember that we are not yet adapted to your atmosphere and as you yourself said if you were to come into our mothership you would have to bring your atmosphere with you. 1It is true that, given enough time, we could have prepared a suit such as your people wear when they go beneath the surface of the sea. This would have enabled you to come into our mothership without changing either your atmosphere or ours. But this would have required considerable time. While we are not nearly so enslaved by time as your race appears to he, nevertheless, we are aboard a craft which derives its operating energy principally from natural differential sources and we, even as the sailors of your race, often find it necessary to ‘sail with the tide.'

"We must leave this area shortly. but we will return to your planet within a few months. We have stored enough of your atmosphere to mix with ours for the time we will be gone. When we return we will contact you again."

Alan Explains the Sampling Craft

DANIEL FRY WAS disappointed, but at least he had the hope of seeing the Sampling Craft again- but it must not come to White Sands.

"I will not be at the Proving Grounds then," he said. "My work here will be finished and I will have to return to California. Incidentally I don't even know your name. Do you people have Christian names?"

"We have names," was the reply, "Though there is seldom any occasion to use them among our own people. If I become a member of your race, I shall use the name of Alan, which is a common name in your country and is nearly the same as my Christian name, which is A-Lan. As to your being in California when we return this should make little difference in our ability to contact you. As I said,

your mind receives well. In fact, if you had a little more practice in resolving mental images, it might have been possible for us to have shown you the details of our own craft without the necessity of your being in it."

"I should like very much to attempt this," declared Fry. "The best way to improve is to practise, and if the details of your motherships are too difficult as a starter, how about trying me out on the details of the Sampling Craft I am in? If I close my eyes and concentrate, won't it be possible for you to give me at least a cross-sectional view of this ship?"

"Hardly." A-Lan replied a little dryly, "You are making the error which your people almost always make, when attempting what you define as extra-sensory perception. In the first place, it isn't 'extrasensory' at all. It is just as much a part of the body's normal perception equipment as any of the other senses, except that it has been used so little by your people that it is still in a rudimentary state of development. Some of your animals and many of your insects have developed this sense to a higher degree than your people.

"You have been accustomed from birth to receiving and resolving visual impressions with your eyes open. You will remember that when you first learned to use a microscope, you were taught that even though there was only one eyepiece, it was best to keep both eyes open. Therefore, do not close your eyes. I will turn off the viewing beam so that there will be no distracting influence.

"Secondly, do not concentrate. Concentration is the attitude of transmission and is almost a complete bar to reception. To receive properly you must achieve a state of complete relaxation. This you have the ability to do, an ability which is remarkable in one of your race.

"In fact it was through this ability, that I first made contact with your mind. It was three nights ago. You had returned to your bed but found it difficult to sleep because the pressure of the events of the day had been unusually great. You made use of a mental device which was very interesting to me because of its simplicity and effectiveness. Do you remember what it was?"

"Oh yes," replied Fry quickly. "I use it often when sleep doesn't come readily. I simply visualise a room which is completely dark except for ten luminous numerals on the far wall of the room. I focus my attention upon these numerals until all other thoughts have been excluded from my consciousness. I then begin, one by one to erase the numerals keeping my mind focused upon the remaining ones, but lowering the degree of concentration with each erasure. I usually fall asleep while there are still several numbers to go, but in no case have I ever remained conscious more than a few seconds after the last one is gone."

"Exactly," A-Lan replied. "And not only does this process relax the conscious mind but it also returns all extraneous thoughts to their proper place in the filing cabinet of the unconscious portion of the mind. Under these conditions the unconscious mind transmits and receives much more readily than the conscious mind ever does.

"I should, perhaps, be ashamed to admit it, but in your case the temptation was too great to resist, and I am afraid that I ransacked your mind as perhaps no mind has ever been ransacked before. I think I can fairly say that I know much more about you than you know about yourself. What I found in your mind was not all that could be desired. Of course, life has been rather harsh with you at times, and I found many scars and a few wounds which are still only half healed. I also found that these same buffetings of fate had given you an unusual depth and breadth of perception and understanding. I decided then that you would be an ideal contact.

"But again we have strayed from the project at hand. I was going to suggest that you use your own method of relaxing your mind. Keep your eyes upon the area of the viewing screen which is now

dark, and when your mind is relaxed, I will attempt to give you a mental picture of the interior of the craft in which you are riding."

It was not necessary for Daniel Fry to visualise a darkened room for with the viewing beam turned off, the compartment in which he was riding was totally dark. He had no difficulty in visualising the luminous numerals on the area of the viewing screen, but when he attempted to exclude the dozens of questions which were beating an insistent tattoo upon the fringe of his consciousness, he found it practically impossible. Eventually he gave up trying to exclude them entirely, and sweeping them as far back as possible, he began to erase the numerals. So great is the force of habit that, as he mentally erased the numerals, his mind cleared so that by the time he reached the last one he was almost asleep.

With the removal of the last numeral, Fry became aware of a picture upon the viewing screen which he had not noticed before. It did not appear suddenly. It seemed as though it had always been there but that he was seeing it for the first time. In the left hand portion of the picture he recognised the compartment in which he was riding and he knew that the picture must represent the interior of the entire craft. He heard a voice coming to him but this time as from a distance. Somehow he knew that it was A-Lan's voice even though the timbre had changed entirely. The voice he had been hearing had been crisp and almost sharp. This one was soft and flowing, with an almost musical quality.

"You are seeing the parts of the ship and its mechanism which your mind is capable of grasping. The large drum like structure just above the central bulkhead is the differential accumulator. It is essentially a storage battery which is capable of being charged from any of a number of natural energy differentials which may be available. By the word 'charged,' I merely mean that a potential difference is created between two poles of the accumulator. The material of the poles has available free electrons in quantities beyond anything of which you could conceive. The control mechanism allows these electrons to flow through the two force rings which you see at the top and bottom of the craft. You are familiar enough with electrodynamics to know that a moving electron creates a magnetic field. The tremendous surge of electrons through the force rings produces a very strong magnetic field. Since the direction and amplitude of flow can be controlled through either ring, and in several paths through a 'single' ring. we can produce a field which is in opposition or in conjunction with any magnetic field through which we wish to travel. This also gives us control of the attitude of the craft with respect to the given field.

"All bodies of matter which are in motion have magnetic fields about them for the reason just given that all matter contains electrons and all electrons in motion produce magnetic fields. The magnetic field of your Earth is very weak in proportion to its gravitational field and it may be difficult for you to understand how acceleration against a strong field can be produced by opposition to a weak one. Just remember what happens when you bring together the 'like' or opposing poles of two 'permanent ' magnets, how the lines of force are pushed outward almost perpendicular to their normal position. So the field of the craft fans outward until it intersects sufficient lines of the Earth's field to produce the required repulsion.

"You may have wondered how long you could breathe the air in the small passenger compartment before it became stuffy and vitiated. You can see here that there are small vents beneath each of the two rear seats with a mechanism to circulate the air from the cargo hold through the passenger compartment. There is no means, in this Sampling Craft of renewing the air, but the large volume of air in the hold would in an emergency supply even four passengers with adequate oxygen for many hours.

"The case which you see just above the differential accumulator contains the control equipment. There is no particular point in going into this since you are already familiar with many types of remote control equipment and servo mechanisms. While ours are infinitely simpler and more dependable than yours, here again it would require several hours of reorientation in physics to give you an understanding of their operation.

"Our time is running out. We have returned you at a velocity somewhat greater than that of the outward trip and you are now almost directly above your point of departure. Since your people, unlike ours, appear to derive a certain degree of pleasure or as you call it 'thrill' from experiencing wide variations of gravity, we can, if you wish, produce during the descent, a condition approaching Zero Gravity or what ,you would term a 'free fall.' To reach this condition fully would be distressing to anyone, as well as somewhat dangerous, but we can approach it closely enough so that while you will still retain some stability you will experience the sensation of weightlessness."

The sudden realisation that the trip was nearly over snapped Fry out of the state of semi-trance in which he had been since he had first entered the craft.

"O.K.," cried Fry. "Try it. I want to experience the feeling."

Instantly the compartment light came on. After the total darkness in which Fry had been, the light was blinding.

While he was attempting to adjust his eyes to the light, his stomach suddenly leaped upward into his chest. For a moment he could plainly feel his heart beating against the lower end of his throat, while his lungs and other upper organs seemed determined to extrude through his ears. He had been through steep dives and sharp pull-outs in aeroplanes, and had ridden many amusement devices calculated to produce the feeling of weightlessness, but had never felt anything like this before. There was no sensation of falling. Fry simply felt as though his organs having been released from a heavy strain, were springing upward like elastic bands when released from tension. Fortunately this sensation was of short duration. In a few seconds he felt almost normal again.

"I don't feel very weightless now," Fry thought and pushed down sharply with his hands on either side of the seat. He rose in a slow and more or less graceful sweep, almost to the ceiling of the compartment. His rise would have been more graceful except that he had apparently applied the force somewhat to the rear of his centre of gravity so that his body tipped forward as he rose and also rotated to his left. By the time he had started to fall back he was almost head downward and was forced to reach out and grasp the back of the seat to right himself. The result was that he came to rest with his knees in the chair and his eyes only a few inches from the back cushion.

It was then that Fry saw something which he had overlooked when he had first entered the ship. It was only a simple design imprinted in the material of the seat, but he recognised the symbol and the recognition must have produced a powerful mental shock wave which A-Lan misinterpreted for fear or pain, for the gravity was immediately normalised, causing him to experience another rough moment as his organs all attempted to occupy the space normally assigned to his intestines.

"What is it?" Fry heard A-Lan's voice, and for the first time there seemed to be a definite trace of concern. Then

"Oh. I see you have noticed the symbol and recognised its significance."

"Yes," Fry answered. "Anyone who has ever read to any extent would recognise the symbol of the tree and the serpent. It is found in the original inscriptions and legends of every race on Earth. It has

always seemed to me to be a peculiarly Earthly symbol and it was startling to see it appear from the depths of Space or from whatever planet you call home."

"These are things which I had hoped to put off until our next contact," A-Lan said. " There is so much to tell and so little time. Our ancestors came originally from this Earth. They had built a great empire and a mighty science upon the Continent which your legends call `Mu' or 'Lemuria.' At the same time, there was also a great empire upon the Continent of Atlantis.*

"There was rivalry in science. Friendly at first, but becoming bitter with the years, as each nation flaunted its achievements in the face of the other. In a few centuries their science had passed the point of development which exists here now. Not content with releasing a few crumbs of the binding energy of the atom, as your physicists are doing now, they had learned to rotate entire masses upon the energy axis. Under the circumstances it was inevitable that the two nations should eventually destroy each other, just as the two major nations of the Earth of to-day are preparing to do.

"But this discussion must wait until we return. Our time is more than up. Already it is requiring too much energy to keep our ship in its present position and we cannot abandon the cargo Sampling Craft. It is on the ground and I will open the door. So long for now, Dan. Take care of yourself until we return."

♦ ♦ ♦

Like a person walking in his sleep. Daniel Fry stepped down from the floor of the Sampling Craft and stumbled a dozen paces through the sand, before turning to look back. The door had closed behind him and as he turned, a horizontal band of orange coloured light appeared about the central part of the Space Ship and it leaped upward as though it had been released from a catapult. The air rushing in to replace that which had been displaced upward, impelled Fry a full step forward and almost caused him to lose his balance. He managed to keep his eyes on the Space craft while the hand of light went through the colours of the spectrum, from orange to violet. By this time it was several thousand feet in the air and as the light passed through the violet band the Sampling Craft disappeared entirely from his sight.

A strong sense of depression settled over Daniel Fry. He felt as though his work and his life had lost all of its significance. A few hours before, he had been a rather self-satisfied technician setting up instrumentation for the testing of one of the largest rocket motors ever built. While he realised that his part in the programme was a small one, nevertheless he had felt as though he were at least travelling in the forefront of progress. Now he knew that the motor, even before it was tested. was pitifully obsolete. Fry had to face the fact that he was a small and insignificant cog in a clumsy and backward science, which was moving only toward its own destruction. For a long true he stood in the sand, looking from the crumpled patch of brush up to the stars.

♦ ♦ ♦

A-Lan had said that they would return in a few months, and that when they did, they would get in touch with Fry again. Did they really mean it or was it just a polite parting gesture? Fry reflected that there must be thousands of people in the United States who could be of more assistance to them than he could be. He had only one course of action open, to wait and hope ....

Patience Rewarded

DANIEL FRY NEVER lost hope of hearing from A-Lan again. He went about his duties with Aerojet confident that he would hear from them once more, though he never ceased to wonder why they chose him as the man through whom they passed their messages to Earth people. His patience was at last rewarded-four long years after his first contact.

Fry owns a small house in the Woods, right up in the Cascade mountains in Oregon, the State to the north of California. Thither he had repaired to spend Easter 1954. He was excited. Something told him that at long last he was going to meet A-Lan. Why he felt like this he did not know but the premonition was there, all the same. Indeed, to find the solitude he needed to make contact he had left bustling Los Angeles and repaired to this quiet spot in Oregon, some eleven miles north-west of Grant's Pass, Josephine County, in glorious wild and rugged mountain country-a splendid change from the noise, heat, and dust of Los Angeles.

It was several days before anything happened. Then, on 21 April, 1 954, when in a quiet woodland glade near his house Daniel Fry clearly heard A-Lan's voice.

"You have been very patient, Dan."

"Is that you, A-Lan? I had a premonition that I should hear your voice again."

"Yes, I am A-Lan," replied the voice. "I have come to reward you for your patience."

"Where are you?"

"I am on the mothership."

"So you were before, but I cannot see the Sampling Craft. Where is it?"

"All our Sampling Crafts are on the mothership."

"What?" Fry's voice sounded disappointed. "I was looking forward to another ride."

A-Lan chuckled.

"No, Dan, not this time. We know you have been patient, but your reward is not going to be what you anticipated." "What is it going to be, A-Lan?" Fry asked, disappointment still evident by the tone of his voice.

"What do you think? " teased A-Lan.

"I don't know," said Fry, puzzled. "A display of motherships and Sampling Crafts in formation escorted by a crowd of ships perhaps."

"No, think how that would draw the attention of your air force. Try again, Dan."

"I really cannot think . . . " Fry paused. "But tell me where the mothership is."

"Several hundred miles above Oregon." Instinctively Fry looked upwards.

"No, it's useless to try and see us, as we are far too high. We are beyond the range of your aircraft here, and as you can imagine, the chance of a powerful telescope finding us is remote. Rather naturally we do not hover in the vicinity of observatories like Palomar when we do not wish to be seen."

"But what are you going to do?" asked Fry.

"I'm coming to that." replied A-Lan. "I'm not going to do anything, but I'm going to tell you some scientific facts that will be new to you Earth men-a different way of looking at several important scientific fundamentals, which will revolutionise scientific thought on your world."

"But why tell me?" protested Fry.

"Because you are just the man we want," answered A-Lan. "You are a scientist and will understand the terminology necessary in such an explanation. However, to make it clear, I shall only refer to discoveries made by Earth scientists, and will not assume knowledge of anything that is not known to your scientists already."

"What have you got to tell me?" asked Fry, now full of anticipation.

"It might be wise," began A-Lan, " first to devote a little time to the consideration of what we will call the ' nonlinearity of physical law.'

"A few years ago, your physical laws were considered to be linear. That is: you had, by trial and error, by observation and test, developed a set of laws which apparently held true for all of the small segment of nature which you were able to observe at the time. You assumed, therefore, that these laws would hold true in any segment of nature, no matter how far removed from your point of observation. When however, the study of physics moved into the microcosm, that is, when you began to examine the interior of the atom, you found there a set of laws which did not agree with those to which you had been accustomed. They, too, appeared to be linear, but operated at an angle to your established laws.

"The same disturbing situation was discovered in the macrocosm. When your astronomers developed the giant telescope capable of peering many millions of light years into Space, they found there, still another set of laws operating apparently at an angle to both of the others. For a time, you attempted to accustom yourselves to the existence of three sets of physical laws, each set linear within its own range of observation, but each set operating angularly with respect to others. Then, with the development of the principles of relativity, you began to realise, or at least you should have realised, that these different sets of linear laws were not actually linear, nor were they different sets of laws, but that they were simply three segments of the one great curve of natural law.

"As long as you were dealing with quantities which could be observed with the unaided eye or with simple instruments, you were unable to detect the curvature, because the segment you were observing constituted such a tiny portion of the curve that its deviation from linearity was too slight to be detected. For most practical purposes connected with the ordinary mechanics of your daily lives, these laws are still considered to be linear. Calculations are simpler when they are so considered, and the resulting error is negligible. For the same reason, a surveyor who is surveying a small lot of land does not find it necessary to take into consideration the curvature of your Earth, because the error resulting from this neglect is not detectable even by the most sensitive of his instruments. If, however, the surveyor is to make accurate measurements of large areas such as a state or a continent, it does become imperative to consider the curvature of the Earth's surface, and to do this, of course, it is necessary to have a reasonably accurate knowledge of the radius of that curvature.

"The necessity of an accurate determination of the radius of curvature of the natural laws was first realised perhaps by Dr. Einstein, who devoted a large part of his life's work to this problem. The results which he obtained have filled a number of text-books, and have been of inestimable value in the progress of the physical science. They proved to be the key which opened the door to the

utilisation of nuclear energy, and as soon as a successful effort is made to reduce these mathematical formulae to simple concepts easily grasped by the mind, these concepts, together with the additional truths which will then become self-evident, will open the door to Space travel with a surety and ease which you would now find hardly possible even to imagine.

"The difficulty with your present mathematical approach to the problem of relativity lies not in any error of the mathematics themselves, but in the fact that the methods and terms used in the attempt to explain them often lead to incorrect thinking and assumptions.

"For example: the best known formula, perhaps, which has emerged from the study of relativity, is the expression $E=MC^2$, which simply states that the .quantity, of energy (in ergs) which is inherent in any mass, is equal to the number of grams of that mass. multiplied by the square of the quantity C. The quantity C you consider to be a constant, in fact the only constant which has survived in a relativistic world.

"In almost every text-book on physics on your Earth today the statement is made that the quantity C represents the velocity of light (in centimetres per second), yet every student in your world who has studied the subject, knows that the velocity of light is not a constant. That its velocity, in fact, varies slightly with each different medium through which it is propagated. Any student who has ever passed a beam of sunlight through a prism to produce a spectrum of colour has demonstrated that not only does the velocity of light vary in different media, but that the change in velocity varies somewhat with the frequency of the light when propagated in material media. This, of course, is the principle upon which all of your spectroscopes are designed, although most text-books state merely that the light is refracted or ' bent ' in passing from one medium to another. There are many who will dispute the statement that the change in velocity varies with the frequency, but when sufficiently precise tests are made, entirely within a single medium, the results indicate convincingly that this is true."

"Yes, but the quantity C refers to the velocity of light in a perfect vacuum, but where in the Universe can we find a perfect vacuum in which to test this assertion?" objected Fry. "Astronomers and physicists have estimated that even in the remotest depths of intergalactic Space there will probably be found, from three to seven nuclear or atomic particles per cubic centimetre. A beam of light travelling at approximately 3×10^{10} centimetres per second would still encounter a rather large number of such particles during each second of its journey. While it is true that the proportionate decrease in velocity which would be produced by this minute concentration of matter is so small that it might be negligible for all practical purposes of measurement, nevertheless it demonstrates the fact that we have chosen as our sole remaining 'constant ' a quantity which actually can never be a perfect constant anywhere in the known Universe."

"Fortunately there is a value to which the quantity C can be assigned which is a constant," replied A-Lan. " More over the assignment of the quantity C to this factor makes possible a much better understanding of the natural laws involved in the propagation of energy.

"The quantity C is actually the kinetic energy equivalent of the mass energy of matter. In other words, if we take a gram (or any other quantity of matter: Newtonian mass) and convert that matter gradually into energy according to the formula $E=MC^2$, and if the resultant energy, as it appeared, were constantly applied to the remaining matter in such a way as to accelerate it uniformly in a given direction, when all the matter had been so converted you would find that you had zero Newtonian mass, infinite inertial mass, and a resultant velocity equal to the quantity C, or approximately 3×10^{10} centimetres per second (with respect to the given reference or starting point). The maximum velocity attained would always be the same, regardless of the quantity of matter with which you started. This is a fact which can easily be verified by anyone who is mathematically

inclined, and who is familiar with the laws of acceleration. The energy required to accelerate each gram of mass to the velocity C through energy conversion is exactly equal to the total energy inherent in any matter having that mass.

"This fact forms the true basis of the statement in our present day physics that the velocity C is a maximum or limiting velocity, since it represents the greatest kinetic energy differential which can exist between two given reference points. Since a good understanding of this concept is of great importance, I will refer to it again, and discuss more fully when I come to energy and matter.

"You must always remember that your ordinary physical laws, as they are usually expressed, do not hold true when carried to an extent which permits the error to be measured, because they do not follow a straight line reaching to infinity, but a curve of finite radius. In a timeless Universe, this curve would be represented by a circle, but since the laws operate through time as well as space, the curve is more readily understood if depicted as a ' sine wave.' In this case the base line of the wave represents zero, and the portions above and below the line represent the positive and negative aspects of the law.

"Thus we see that there are points and conditions in which the natural laws reach zero value with respect to a given reference point, and that beyond these points the laws become negative, reversing their effect with respect to the observer."

"The constant repetition of the term 'reference point' or 'observer' is necessary to emphasise the frequently unrecognised fact that none of the basic factors of nature have any reality or significance except when considered from a specified position or condition."

Gravity

PERHAPS THE GREATEST obstacle to Mans achievement of his dream of Space travel has been a factor which has been given the name of gravity," went on A-Lan.

" Its 'discovery' is usually credited, in your elementary school text-books, to a seventeenth-century mathematician and physicist, Sir Isaac Newton. Actually, of course, every man 'discovers ' gravity soon after birth and the stone-age man who first rolled a boulder down upon the head of the cave bear who was attempting to scramble up the cliff after him was making a practical application of this force. It was, however, Sir Isaac Newton who first made a complete mathematical analysis of the subject on your Earth. His conclusions were compatible with subsequent observation and test, and were virtually unchallenged until the dawn of the era of relativity.

"In brief, his conclusions were that gravity is a quality which is inherent in all matter, and that it manifests itself as a mutual attraction between all bodies of matter. The value of this attraction between any two given bodies was said to be directly proportionate to the product of their mass, and inversely proportionate to the square of the distance between them. The attraction between the Earth and an object near its surface is known as the weight of the object. The difficulty with the statement that the force varies inversely as the square of the distance lies in the implication that if the distance becomes zero, the force should become infinite. Thus it would at first seem that a man standing or lying upon the surface of the Earth would be one of two bodies between whom the distance was zero, therefore, the weight of the man should be infinitely great. The reply to this assumption is that the force acts as though it originated at the centre of the mass, called the ' centre of gravity,' and that the man on the surface of the Earth is still some four thousand miles from its centre of gravity. This explanation, however, creates a new problem in that, if we accept it literally, we must assume that if there were a well or shaft extending to the centre of the Earth, and if a man descended this shaft, his

weight would increase as he approached the centre of gravity, becoming infinite as he reached it. Actually, of course. his weight would decrease. becoming zero when his centre of gravity coincided with that of the Earth. So the are forced to the further explanation that gravity is inherent, not in ' bodies,' but in particles of matter, and since a mail at the centre of the Earth would have an equal number of particles attracting him from every direction, the resultant of the forces would be zero.

"If we assume the gravity to reside independently within each atom, our problem is solved as far as the marl and the Earth are concerned, but if we look within the atom itself in the attempt to find the point where the distance becomes zero. and the force infinite, we find that the same problem again confronts us. We have not solved it, the have only changed our scale of observation. There is conclusive evidence that the attraction, called the binding energy, which exists between the Newtonian particles (the protons and the neutrons) is intense almost beyond our ability to describe. This force, however, does not increase uniformly with increasing mass, but at certain points not only reaches zero but actually becomes negative.

"We can demonstrate this fact by adding a single unit of Newtonian mass, a neutron to the nucleus of an atom of uranium 235. When this is clone, we find that the gravitational force within the nucleus, instead of increasing actually becomes negative. that is. the attraction between its parts becomes a repulsion, and the parts begin to separate with considerable brisance. During the expansion. however, several new centres of gravity are formed. which, because of the smaller amount of mass involved in each, are strongly positive. The result is that two or more simpler atoms are formed, plus a few neutrons which have acquired too great a velocity to be captured by this regrouping process.

"This phenomenon, if carefully examined and considered, will furnish several strong clues to the nature of gravity itself, but let us for the moment content ourselves with the observation that it demonstrates that a gravitational field can, under certain conditions, become negative.

"Because of the manner in which our gravitational laws have been expressed, it has commonly been assumed that a gravitational force can manifest itself only as an attraction between two bodies of matter. This is not, however a necessity of thought, since there is no logical reason why it should necessarily be true: In fact. if it were true, it would set gravitational fields apart as the only force fields with which you are familiar which could not produce a repulsion, as well as an attraction between bodies of matter. The reason for the assumption of a universal attraction is simply that all of your early and limited observations seemed to indicate that this was true. However, as I have already mentioned, any number of observations, if made on a sufficiently limited scale, will tend to indicate that the Earth is flat, rather than spherical.

"For many years a school of thought existed which recognised that gravitational fields, like all other fields, must possess a dual polarity. They called these poles gravity and levity. They assumed that some objects and materials normally possessed the quality of levity, while others normally possessed the quality of gravity. An object possessing levity would be repelled by all objects possessing gravity. The theory eventually became discredited, and was almost universally discarded, not because it was ever disproved, but because so many attempts had been made to assign this quality of levity to objects and materials which did not actually possess it. For instance it was, for a time, assumed that gases such as hydrogen and helium possessed levity because when they were contained in a light bag or envelope, they were observed to rise against the gravitational field. It was soon demonstrated, however, that their rise was caused, not by any quality of levity, but simply because of the fact that their specific gravity was less than that of the air they displaced. After a number of unsuccessful attempts to assign the quality of levity to specific materials or objects, the theory fell into disrepute to the extent that the very word levity has become synonymous with humorous nonsense. Nevertheless, the Earthly philosophers who developed the theory were

perfectly correct in their primary postulate. They erred only, in failing to realise that gravity and levity are not properties of specific materials but are conditions under which all matter may come.

"We have now observed negative gravitation in the microcosm (the interior of the atom). we also observe it in the macrocosm (between the galaxies).

"Many technical articles have been written in recent years concerning 'Our Expanding Universe.' yet where, in any of them can you find any logical explanation or reason why it should expand at all? Under the theory of universal attraction. all of the matter in the Universe should be rapidly coalescing into one gigantic lump. Instead, we find that every one of the large groups of stars which we call 'galaxies,' is rapidly retreating from every other group, at velocities which increase with their distance from the observer. Velocities of recession exceeding twenty-five thousand miles per second have been calculated.

"A number of interesting but hardly convincing theories have been advanced in the attempt to reconcile the observed state of the Universe with the existing concept of universal attraction. Some of your cosmic theorists have proposed that at one time all of the matter in the Universe was contained in a single tremendous star, or 'atom.' For some reason which is not given this atom exploded, hurling outward the matter which has become the star clusters. and imparting to them the motion which we now observe. several billions of years later. I shall discuss this theory further later on and will only point out here that such a theory will not stand up when examined under our linear concept of physical law.

In the first place, such an inconceivably huge mass of matter, even at the very great temperature which was assumed for it, would, under Newtonian laws, produce a gravitational field so intense that no velocity less than that of light itself would be an 'escape' velocity. In fact, it has been calculated that even the light emitted by this huge sun would not escape completely, but would circle in a comparatively small orbit about it.

"Through the concept of the curvature of physical law, however, we see that the addition of mass to an existing body does not, necessarily, increase the force of attraction between its parts, but may under certain conditions, cause the field to become negative and the attraction to become a repulsion. We can explain the observed actions of the present Universe by postulating that an attraction exists between the individual bodies within a galaxy. because their total mass and distance is such that they are within the positive portion of the gravitation curve with respect to each other. In the vast spaces between the galaxies however, the curve dips below the zero line with the result that a repulsion exists between the galaxies themselves. This also explains why matter, although rather evenly distributed throughout the known Universe, is not distributed uniformly, but is found in quite similar concentrations at comparatively regular distances."

"These explanations may be very interesting to the astronomer or to the theoretical physicist, but how can they help us in achieving Space travel?" demanded Fry.

"We must have some understanding of the physical laws before we can make the proper use of them in attaining our own personal ambitions," replied A-Lan.

"In his dream of Space travel, Man has generally considered only three possibilities of escaping from the Earth. First, gravity must be destroyed. That is, the operation of the gravitational field must cease between the Space craft and the Earth, so that it will not hinder the departure of the craft. While a number of highly imaginative stories have been written along this line of thought, no theory has ever been evolved, or test conducted, which could give us any hope that such a condition can be achieved.

"Despairing of the first possibility, we pass on to the second. Gravity must be shielded. Some type of screening material must be interposed between the craft and the Earth to cut off or absorb the gravitational field so that while it still exists, it will no longer act upon the craft. Here again you have found imagination raising your hopes, and reality disappointing, for no material has been discovered which shows any promise of fulfilling such a function. With your hopes considerably subdued. you pass on to the third possibility. Gravity must be overcome. You must apply a greater force so that you can rise against the pull of gravity, even though you trust pay an exorbitant tribute of energy for each foot of progress.

"In this last plan, you have a slight degree of initial success. Rocket motors have fought and struggled their way upward against the implacable. if impersonal, pull of the Earth's gravitational field, for distances of up to two hundred and fifty miles. While this is a very small step toward complete escape from the Earth. the fact that any progress at all could be achieved has so stimulated the age-old ambition that science is now devoting a large portion of its total efforts to this 'last hope of escape.'

When Man attempts to attain his ends by pitting one natural law against another, he usually finds that it is a wasteful and laborious process. While it is true that it is perfectly possible to propel a rowboat by throwing rocks from the stern, it is not a method which an intelligent man would choose if he were aware of other possibilities. In the first place. the thrown rock must accelerate, not only the boat. but all the rocks which remain to be thrown. If a long journey were planned. the greatest problem would be to find enough room in the boat to store the required number of rocks. Since the thrust produced is equal to the mass of the rock multiplied by the velocity of its ejection, it is obvious that there are three limiting factors. First, there is the total mass of the available rocks, which is limited by the size of the boat which contains them. Second, there is the total amount of energy available. (This is a factor only because you have so little understanding of the true nature of energy.) The third, and at the present time the most serious factor, is the limited mechanical strength of the throwing arm.

"In a rocket motor, the 'rocks' are represented by a gas produced by combining or 'burning' the fuels within the combustion chamber. The gas, at a high temperature and pressure, is expelled through an opening or venturi in the stern. Since the amount of fuel is limited by the size of the rocket, the only means of increasing the total thrust is to increase the velocity of ejection, but this can only be accomplished by increasing the temperature and pressure of the gas within the combustion chamber. Regardless of the amount of energy which is available, the amount of thrust which can be produced is limited by the ability of the chamber to withstand the temperatures and pressures involved.

"Since these limits are reached (and often exceeded) by ordinary chemical energies, it is clear that the vastly greater energies available in nuclear reactions are, at the present time at least, of academic interest only to the rocket engineer. In the case of craft which remained in your atmosphere, of course, more 'rocks ' could be taken aboard while in flight, by scooping up the atmosphere through which the ship was travelling, and allowing the surplus energy to act upon it. In Space flight, however, this is not possible, and it is hardly likely that the efficiency of the rocket motor can be increased sufficiently in the near future to permit of practical or economical Space travel.

"Actually, the rocket has been obsolete for centuries. There has not been a single basic advance in the rocket concept since your year 1214 A.D., when the invading hordes of Genghis Khan were met by the military ordnance rockets of the Chinese defenders in their walled cities, more than seven hundred years ago. True, you have produced stronger combustion chambers, you have improved slightly the shape of the venturi, and you have developed fuels with considerably higher specific impulse, but you have done nothing to advance the basic concept. You are still propelling your boat by throwing rocks over the stern.

"Earth men now living will stand upon the surface of Mars and Venus, but they will not go there in a rocket. There are better and simpler ways.

"It is time to re-examine your position to see if there is not something you have overlooked. Have you forgotten the old saying, 'If you can't lick 'em, join 'em '?"

"You have tried for centuries to 'lick' the force of gravity. You have tried to destroy it, and failed. You have searched for some method of shielding yourselves from its effect. You have not discovered it. You have attempted to overcome it by opposing it with superior force, and found it a wasteful and cumbersome process. Isn't it about time you gave up the idea of fighting the force of gravity, and began to consider the possibilities of making use of it?

"You have learned that gravity, like all natural factors, has a negative, as well as a positive value. If, after building your Space craft, you could arrange conditions so that the ship was in the negative portion of the gravitational curve, it would fall away from the Earth as easily and as naturally as a stone dropped from a tower falls toward the Earth."

"Yes, but while negative gravitational fields have been shown to exist," objected Fry, "they have been found only within the atom and at inter-galactic distances. How can we place a Space Ship within the negative portion of the curve, with respect to the Earth?"

"The natural laws are not absolute, but relative," replied A-Lan. "That is, the size and shape of the curve of one law is dependent upon the value and position of the others. We have seen that the nucleus of the atom of uranium 235 dips below the zero line with the addition of only one mass unit, making a total of 236, yet the nucleus of the atom of uranium 233, although close to the zero line is still on the positive side of the curve because of the fact that the shape of the gravitational curve is modified not only by the mass present but also by the number and position of the electrical charges." "But there are the same number of electrons (92) in each of these atoms," Fry pointed out.

"I am referring not only to the charges in the outer shell of the atom but to those within as well." replied A-Lan, "and especially to the fact, not always realised that the neutron possesses both a positive and a negative charge, although when united within the neutron they are not discernible as charges, but exist as energy which produces the gravitational field.

"When you acquire a better understanding of the laws, you will be able to produce any shape of curve you desire, with the Earth as one reference point and the Space craft as the other.

"Suppose you were to hand a bar magnet and a similar bar of soft iron to a man who was intelligent, but uneducated, with the request that he examine and test the two objects in order to determine their properties. One of the properties which the researcher would be certain to list would be the ' inherent ' property of mutual attraction between the two objects. He would observe that when either end of one bar approached either end of the other bar, a condition of attraction was observed. He would probably conclude that the attraction was an inherent quality of these objects, and that it would continue to persist regardless of anything which could be done.

"We know, of course, that if a length of insulated wire were wound around the soft iron bar, and a flow of electrons were induced in the winding, the two bars could be made to exhibit a repulsion as readily as an attraction. Note that in this case we have not destroyed the field of the permanent. magnet, we have not shielded the field, nor have we overcome it. We have simply produced a field which is in opposition to it, or to state the case more concisely, we have polarised the field, by placing one end of the soft iron bar within the negative portion of the magnetic curve with respect to each end of the permanent magnet which is already so polarised.

"The same possibility exists with respect to gravitational fields except that the results are not obtained in quite the same way. It is not too difficult, however, to work out means of polarising a gravitational field, once we discard the old assumption that it is impossible."

"Whew," ejaculated Fry after A-Lan had finished speaking. "Do you think you could sum up what you have told me about gravity before we go on?"

"Good idea," replied his friend. "Here we go. These are the seven corrections and additions to the gravitational theory as it is now understood on your Earth.

“First, the law of gravity is not a linear law but follows a curve common to all factors of nature.

"Second, the gravitational field does not diminish precisely as the square of the distance as Newton believed, but because of the curvature of natural law it diminishes normally at a slightly greater rate so that it reaches zero value, not at infinity as is usually supposed, but at a finite distance or degree of separation. Beyond this distance or degree of separation the force becomes negative.

"Third, we can define a gravitational field as negative when the application of the factor called time tends to increase the degree of separation between any two reference points in the factor called matter.

"Fourth, the value of the gravitational field at any given point is controlled by the values of the other factors of nature at that point.

"Fifth, the electric charges within the atom are a factor which modulates the shape of the gravitational curve of the nucleus.

"Sixth, gravity is not the enemy of Space travel. It is a friend, but there must be true understanding before the friendship can bear fruit.

"Seven, it is perfectly possible to produce a negative gravitational field between the Earth and a given object on or near its surface by the proper application of moving electric charges. Such a field would be effective only with respect to the given object. All other matter in the vicinity would remain within the positive portion of the curve."

Matter and Mass

MUCH OF THE confusion which exists in our scientific concepts today is brought about by our failure to distinguish carefully between matter and mass," continued A-Lan. "Until a comparatively few years ago, it was assumed that mass was a property which was exhibited only by matter. Upon closer examination, however, it appeared that energy also possessed mass, as when energy was added to a body of matter, the mass of the body was increased.

"We should, perhaps, pause at this point to define the terms which we are using lest we add to the confusion instead of resolving it. Mass is defined as resistance to change in the existing state of motion. It is measured by the amount of the energy which is required to produce a given change in velocity. All matter has the property of mass, but not all mass has the properties of matter. For our purpose now we will postulate that there are two types of mass, inertial mass, which is simply the property of resistance to change in a state of motion, and the mass inherent in matter, which we will call Newtonian mass, because it includes all mass which obeys the original laws laid down by Sir Isaac Newton. Since you may be under the impression that all mass obeys the Newtonian laws, let us pause here long enough to examine the facts and to point out the differences in the properties of inertial and Newtonian mass.

"All physicists of today are agreed that the electron has mass. Yet if it were possible for us to hold an electron between two of our fingers and then suddenly release it, we would find that there was not the slightest tendency for the electron to fall to the Earth (unless the surface happened to be positively charged at the moment). The electron is not in the least affected by the gravitational field of the Earth, so long as it is at rest with respect to that field (if the electron is moving through the field, however, the direction of the motion will be affected).

"The electron has mass only because it has an electric charge. As we know, when an electric charge is accelerated in Space, a magnetic field is produced, and energy is required to produce this field. The energy 'spent' in producing this field is said to be the ' mass ' of the electron, since it is the entire cause of its resistance to acceleration. The greater the degree of acceleration, of course, the more intense the field, and the greater the amount of energy required to produce it. So we say that the electron gains 'mass ' with every increase in its velocity. If an electron could be accelerated to the velocity C (commonly called the velocity of light), it would have acquired the maximum velocity with which energy can be propagated. It is obvious, therefore, that no amount of energy could further accelerate this electron (with respect to its original reference point), so it would be considered to have acquired 'infinite' mass.

"Let us pause a moment to examine this statement carefully since it is a point upon which there is much confusion. The electron would have acquired infinite mass only in reference to its original energy level. If observed from a reference point which had itself received the same degree of acceleration, the mass of the electron would not have changed a particle. This increase of inertial mass with increasing velocity is simply the measure of the kinetic energy differential between the observer and the point which he is observing.

"Let us make a simple analogy, in the hope of making this more readily understood. An observer is stationed in 'free Space ' far from any gravitational or other fields which might affect the results of the experiment which he proposes to make. He has in one hand, a sphere of cork or other light material which has a mass of 10 grams. In the other hand he has a pistol which fires bullets also having a mass of to grams and a velocity of 1,000 feet per second. The man holds the ball out at arm's length, and fires a bullet from the gun into it. The bullet is not absorbed by the cork, but shares its kinetic energy with it, so that after the impact, the bullet and the cork ball each have a velocity of 500 feet per second. The observer now fires a second bullet at the cork. This bullet also has a velocity of 1,000 feet per second with respect to the observer, but now the target has a velocity of 500 feet per second in the same direction, so that there is a differential of only 500 feet per second which the bullet can share with its target. After this impact, the bullet and the ball each have a velocity of 750 feet per second. When the observer fires the third bullet, He finds that now there is a differential of only 250 feet per second between it and the target, so that the velocity of the target is raised by only 125 feet per second, and so on.

"The observer notes that each succeeding bullet, although it has the same energy with respect to him, produces a smaller and smaller acceleration in the target. He would observe that the `mass of the target ' (its resistance to acceleration) appears to increase with its velocity. If he made mathematical calculations based upon his observations, they would show that the greatest velocity which he could ever induce in the target would be 1,000 feet per second (the velocity of the bullets), and that to produce this velocity it would be necessary to fire an infinite number of bullets. His experiment demonstrates conclusively that as the velocity of the target approaches 1,000 feet per second, his ability to accelerate it further approaches zero. Persons with lesser intelligence or insight than our observer might be convinced that this figure of 1,000 feet per second was an absolute and inescapable limit. The observer, however, as we said, has greater understanding. After he has accelerated his target to the 'limiting' velocity of 1,000 feet per second (by firing an infinite number

of bullets), he steps aboard a small Space Ship (with which he has thoughtfully provided himself), and takes off in the direction of the target. He accelerates his ship to a velocity of 1,000 feet per second, with respect to his starting point, and now finds that he is back upon exactly the same energy level as his target, and he can begin his shooting all over again. He observes that his first bullet accelerates the target to a velocity of 500 feet per second with respect to his new reference point, and he notes that the ‘infinite mass' of the target returns to its original to grams, as soon as he reaches the same energy level. He realises then that the 'increasing mass' of the target is only the measure of the kinetic energy differential which exists between them. The mass approaches infinity only as the energy level approaches that of the accelerating force. (In this case it is 1,000 feet per second.) In the case of the quantity C, usually called the velocity of light, the differential is equal to the total energy inherent in matter (about 3×10^{10} centimetres per second or 9×10^{20} ergs per gram). It is, therefore, a maximum of limiting velocity, but only with respect to a given reference point.

"When I was telling you about the non-linearity of physical law. I said that the energy inherent in a gram, or any other quantity of matter is precisely the quantity of energy necessary to accelerate its mass to a velocity equal to the quantity C by energy conversion. This statement may be hotly disputed by some of your Earth students who have not yet learned to distinguish between matter and mass. Their argument is to the effect that no mass can ever be accelerated to the velocity of light since the mass would then be 'infinite' and consequently the energy required to produce the velocity would also be 'infinite.' The incorrectness of this assumption can be demonstrated simply by pressing the button of a pocket flashlight. A beam of light will be produced which any physicist will agree has mass and which, by its very definition, is moving at the velocity of light. Yet all the energy required is released by a small amount of chemical change taking place within the cells of a battery."

Space

WELL, A-LAN, THIS is all most fascinating," commented Fry. "Can you tell me anything about Space? I know that among all of the great basic factors of the Universe, it is perhaps the most difficult to define or explain. While many of our greatest philosophers and scientists have attempted definitions, few have succeeded in offering anything which the average mind could readily grasp. The German mathematician Leibnitz said, 'Space is simply the order or relation of things among themselves.' Several centuries afterwards, Dr. Einstein used almost identical terms. 'Space has no objective reality except as an order or arrangement of the objects we perceive in it.' "

"Yes," replied A-Lan, "I was coming to that. The average Earth man's definition of Space is: 'That in which matter can be placed ' or ' that which matter occupies.' This last definition is subject to dispute by those who maintain that matter does not occupy Space, but is itself, only a warp or distortion in Space. Another school of thought insists with equal vigour, that while matter does occupy Space, it creates a warp or distortion in the Space surrounding it. Since both of these concepts are subject to the same set of mathematical laws, the same laws can be offered in support of either. There is little, however, in either of these assumptions which seems to furnish a good foundation for understanding and it is understanding rather than algebraic formulae that I am trying to help you to find.

"For our purpose, a simple definition will suffice. Space is that which separates bodies of matter, whether these bodies be atoms, galaxies, or any component part of either. We can extend this definition by stating that the degree of separation which exists between any two bodies is determined by the degree of curvature of the natural laws which exists between them.

"In making observations, of course, we must remember that, since the natural laws are relative, the mass of the body itself influences the degree of curvature. In the theories of relativity given to the world by Dr. Einstein, the natural laws, in general, retain their linearity, but the Space in which they operate is considered to be curved. This concept offers the simplest mathematical presentation, since all of the observed deviations from linearity can thus be explained by a single postulate. Unfortunately, like most of your mathematical presentation, since all of the observed deviations from linearity can thus be explained by a single postulate. Unfortunately, like most of your mathematical presentations, the concept offers but little for the human mind to grasp. A curved Space cannot be pictured mentally, nor can it be drawn upon paper. There is always something remaining outside the curve. Furthermore, attempts to rationalise this concept lead to many paradoxical statements which become more and more evident, the greater the effort to explain.

"One of the best efforts by an Earth man to bring to the average mind an understanding of the principles of relativity, was made by Lincoln Barnett in his well-known book, *The Universe and Dr. Einstein*. Because of its careful preparation and its explicit presentation of present theory, however, it brings out very clearly the paradox which must exist between successive assumptions. For instance, reference was made, as I have already remarked, to the theory of Abbe Lemaitre, which supposed that at one time all the matter in the Universe was contained in one huge lump or star. Since the curvature of Space is considered to be determined by the amount of density of the matter present in it, at that time the Universe was very small. That is, it had a very high degree of curvature. Light and other forms of energy do not move outward from this curve, but follow the circumference, so that the light emitted by this body, after a comparatively short journey, returned to its starting point. No attempt was made to speculate upon the length of time in which this body had existed, or the origin of the matter and energy of which it was composed. The theory merely supposed that, after perhaps an infinity of quiescence, this body suddenly exploded. Portions of the mass moved outward in all directions and thereby enlarged the radius of Space. If the radius of Space were increased, it is obvious that the matter did not follow the curvature of Space, but actually moved perpendicularly to it (or perhaps at a tangent). At any rate, we see that while the radiated energy followed the 'curvature' of Space whose radius was determined by the mass and density of the matter, when the matter itself expanded, instead of following the curve, its motion increased the radius.

"It is interesting to note that the statement is repeatedly made by man on Earth that this sudden expansion began about two billion years ago, yet a few moments ago I stated that the calculated radius of the Universe is now about thirty-five billion light years. Simple calculation would indicate then that the Universe or at least that portion which we call Space, must have moved outward at an average velocity equal to about seventeen times the velocity of light. Either this velocity of expansion is still maintained or at some period in the past it must have been even greater.*

"These statements raise some perplexing questions in men's minds. In your theories of relativity it is assumed that light follows the 'curve' of Space. Yet it is difficult to picture a photon following a curve whose radius is expanding at a rate equal to seventeen times the velocity of the particle."

"In the book *The Universe and Dr. Einstein*," put in Fry, "it is also stated that while Space is expanding rapidly, the matter of the Universe. which is likened to ' inelastic patches on the surface of an expanding balloon,' is not expanding

* Since Daniel try talked with A-Lan it has been announced by Walter Baade of the Mount Wilson and Palomar Observatories that. as' a result of the recalibration of the cephid variable stars, the previously calculated size of the Universe trust be increased by a factor of 2.8 However, the correction factor also applies to the time of expansion, so that the rate of expansion remains the same-*Author*. with the Space, since if it were, we could not detect the expansion.

"If it is Space that is expanding, it is difficult to understand why we have never detected the increasing distance between the Earth and the Moon or the Sun. No attempt was made to explain why the space which exists between the individual atoms, and between the component parts of those atoms, should not expand also."

"None of these difficulties, of course, invalidate any of the mathematical laws from which the concepts have been derived," A-Lan pointed out, "but they do emphasise the great need for explanations which are more compatible with reason and understanding."

"In the above case," asked Fry, "would it not be simpler to assume that the degree of separation which exists between the galaxies, when considered as individual bodies, is apparently increasing because they occupy opposite portions of the sine curve of natural law?"

"If we exchange our postulate of linear laws and a 'curved Space' for a concept which incorporates the curvature of natural law," replied A-Lan, "we find that we have not thereby destroyed or invalidated any of your present mathematics, but we have achieved a position from which the operation of the natural laws can be pictured by the human mind, and can be charted upon paper. Thus we have taken a great stride in the direction of understanding."

"Can you sum up again?" asked Fry.

"Certainly," replied A-Lan. "There are three major points to remember in our discussion about Space.

"First, our definition-Space is that which separates bodies of matter. This separation is a vector function of the time, energy, and mass differentials.

"Second. the degree of separation which exists between any two bodies, or reference points, determines the degree of curvature of the natural laws between them.

"And third, the natural laws are relative. That is, the value of one can be altered between any two reference points by altering the value or relationship of the other. This last fact should always be borne in mind when we hear some dogmatist solemnly declare that we are forever barred from reaching the stars by the hopelessly great degree of separation between us.

The Quantity C

WE HAVE SEEN," went on A-Lan, " that the factor known as the quantity C has a greater significance than is usually credited to it. It is not merely the velocity with which light and other forms of energy are propagated in a vacuum. The quantity C is a degree of energy differential. We can define it as the maximum differential which can exist between two reference points in the factor which we call matter. We can also define it as the minimum differential which can exist between a reference point in matter, and one in energy. This is only true, however, when the reference point in matter is at the same energy level as the observer.

"One of the postulates of the theory of relativity is that as a body of matter accelerates and approaches the velocity of light, or a kinetic energy differential equal to the quantity C with respect to a given observer, the body loses dimension in the direction of motion. If the velocity reaches the velocity of light it will appear to have lost all of its dimension in this direction. To this observer it would no longer be matter, since matter, by definition, requires three dimensions. The matter would have become energy in so far as the original observer was concerned since it would now exhibit a kinetic energy differential equal to the total energy inherent in the original matter.

"This statement, however, seems to produce a misconception in the minds of many Earthly students of physics. I will therefore attempt to clarify the concept by the use of a simple analogy. Let us assume that we have three Space Ships assembled at a given point upon the surface of the Earth (or at a given point in Space). For the purpose of this analogy we will assume that the ships are capable of any desired degree of acceleration. We will dispatch two of these ships into Space, flying side by side in a given direction. We will launch the remaining craft in the opposite direction in Space.

"We have an observer upon each of the three craft and a fourth observer who remains at the point from which they departed. Let us call the ships which departed together as A and B. the ship which is moving in the opposite direction as C, and the observer at the starting point as D. When we have accelerated all three of the ships to a velocity equal to one half that of light (with respect to the starting point) we pause to determine what changes. if any. have taken place. To the observer at the starting point D, the three ships have become slightly shorter in the direction of their motion, and have gained a small amount of `mass.' but are otherwise unchanged. The observer upon the ship C, however, discovers that while he and his own ship appear to be unchanged, the ships A and B have lost all dimension in the line of motion, because they have reached the velocity C with respect to his reference point. They have ceased to exist as matter and have entered the plane of energy. The two observers upon the ships A and B also note that C has ceased to exist as a material object, but when they examine themselves and each other, they find that no change whatever has occurred to them or to their ships since they are all upon exactly the same energy level and no differential exists between them.

"We will now accelerate all three ships to the velocity C with respect to their starting point D. At this velocity the three ships cease to exist materially insofar as the observer at D is concerned, since they have entered the plane of energy, and are also at the zero point of the curve of time with respect to him. The observer upon the ship C would note that the ships A and B were again in existence but that they were now in the negative portion of the curve. Since you may find this concept somewhat difficult to grasp at the first attempt I will explain it further and give a simple analogy when we come to discuss Time.

"The analogy I have just made also demonstrates that the terra velocity has no meaning or significance except as an observed kinetic energy differential between two specified points of reference.

"If we examine this analogy carefully, we will find that we have demonstrated the most important aspect of the factor which I have called quantity C. C is a constant, the only true constant in the Universe, because it is the pivotal point about which the natural laws become manifest. It is the factor for which many great physicists have spent years of search, even though they had it constantly in their possession. In short, the quantity C is the measure of the radius of curvature of natural law. It is the factor which will enable us to determine precisely the degree of change in the curvature of one law which will be brought about by a specified change in the application of the others. It is the factor which will eventually tell its how to place our Space craft in either the positive or negative portion of the gravitational curve with respect to the Earth or any other planet which we may choose to visit.

"When we state that the quantity C is the radius of the curvature of natural law, we mean simply that if a differential of energy equal to this quantity exists between the observer and the point which he is observing, the natural laws will be suspended. If the energy differential is in excess of the quantity C, the laws will appear to operate in reverse at that point. As I said before I will show this effect by a simple analogy when we get to the factor called Time.

"While we have repeatedly referred to the quantity C as an energy differential, we have hitherto considered it only in terms of kinetic energy. Some may believe that it can be reached only when there is a rate of increase or decrease in the degree of spatial separation between the reference points, equal to 3×10^{10} centimetres per second, or in simpler terms, a velocity equal to that of light. It is necessary therefore to point out the fact that an energy differential does not necessarily manifest itself as a velocity. It can also exist as a frequency. Our present laws of physics state that the energy level upon which an electron, a photon, or other particle exists is proportionate to its frequency. The mathematical rule is E equals Fh where E is the energy. F is the frequency and h is a factor called Planck's constant.

"We can now see that a frequency differential which by the just mentioned formula is equal to 9×10^{20} ergs per gram also represents the quantity C. When such a frequency differential exists between the observer and the point which he is observing. we again find that the natural laws at the observed point reach zero value with respect to the observer.

"If the frequency differential exceeds this value. the action of the laws will become negative. A material object such as a Space craft upon or near the surface of the Earth would cease to exist as matter and would enter the plane of energy in so far as the observer on Earth was concerned. but as we have previously pointed out, an observer upon or within the object. whose frequency or energy level had been raised to the same degree as that of the craft, would be unable to detect any change.

"You Earth men must clear your minds of the thought block produced by the assumption that the quantity C is a factor of absolute limit. You must realise that it is a limiting factor only with respect to two given reference points, and that it is perfectly possible to conceive of a series of consecutive reference points between each two of which a differential equal to the quantity C may exist."

Time

IN HIS EXAMINATION of the natural laws or facts of the Universe," said A-Lan, "Earth man is greatly handicapped by the fact that in so far as Time is concerned, he has never progressed beyond an unidimensional perception. If you are familiar with the analogies used to explain some portions of the theory of relativity, you will recall that in attempting to achieve a concept of a four-dimensional continuum, the student is asked first to imagine a man who is conscious of only one dimension in Space. His entire Universe consists of a single line. If a dot were placed on the line in front of him, and one behind, he would be completely imprisoned, since he would not be able to conceive of going over or around them. As his intelligence and consciousness developed, he would eventually become aware of a second dimension, and to imprison him then, it would be necessary to enclose him in a circle. With further development, he would become aware of a third dimension in which a sphere would be a prison, and so on.

"Earth men are now conscious of three dimensions of Space, and have done considerable mathematical reasoning in regard to a fourth. Unfortunately, in so far as Time is concerned, your consciousness has never progressed beyond the first dimension. You are confined to a single line in Time. You have no concept of lateral motion, nor can you even turn around upon that line. You can only go forward. Many of the difficulties which you encounter in your attempt to understand the operation of the natural laws arise because of your severely restricted concept of the nature of Time.

"Time has often been referred to as the 'fourth dimension' by those who attempt to explain our present concept of relativity. It is usually pointed out that, since all known bodies of matter in the Universe are constantly in motion with respect to each other, if you wish to describe the position of any body, it is necessary to give a point in Time as well as spatial relationship to any other body or

bodies. There is, however, a more convincing method of demonstrating that Time is a dimension, although I believe it would be more precise to consider it as the first dimension rather than the fourth since it is the one dimension in which all motion must take place. Earth men are, at the present, conscious of three dimensions of Space, and you know that motion can take place in any one of the three, but whichever dimension of Space is involved, the motion must also take place in Time. Your term for the rate of motion is the word velocity, which is defined as being the degree of change in location per unit of Time. If an object has a velocity of 1,000 feet per second, with respect to our point of observation, we will see that in one thousandth of a second the object will have moved one foot. In one millionth of a second it will have moved only one thousandth of a foot, and so on. We can easily see that if the Time becomes zero the motion must also become zero.

"The science of photography on Earth has reached a state of development which permits you to take photographs with very short exposure times. By the stroboscopic method of photography, which is now being superseded by an even faster method. you were able to take several hundred thousand consecutive pictures in one second. In these pictures even the fastest projectile seems frozen into immobility. You have taken pictures of a rifle bullet penetrating an ordinary electric light bulb, in which three complete and consecutive pictures have been made between the time the bullet first touched the bulb and the time that the first crack appeared in the glass. In these pictures, the bullet appears to be completely motionless. Of course. the taking of the pictures actually did involve a very small elapse of time, and so a very small amount of motion did occur during the taking, but it again illustrates the fact that no motion which we can perceive can take place except within that dimension of Time of which we are conscious.

"Having pointed out the limitations of your consciousness concerning this factor which we call Time, let us now go back and examine it as best we can, with that degree of consciousness and understanding which you have.

"I will again attempt to choose the simplest possible definition. I defined Space as 'that which separates bodies of matter,' so I will define Time as 'that which separates events.' (If there be no discernible separation in this respect, the events are said to be simultaneous.)"

"But events may be separated by Space as well as by Time," objected Fry.

"Although this is usually considered to be true," replied A-Lan "it forms a stumbling block which has precipitated many a philosopher into the quagmire of misunderstanding and paradox. The difficulty arises in the attempt to define the term simultaneous. If two events are separated by Space, how shall we determine whether or not they are separated by Time? The observer cannot be present at the site of both events, and so must observe one or both of them through the separation of Space, and therefore through the curvature of natural law which the separation represents.

"In referring to this problem in the introduction to his first book on relativity. Dr. Einstein pointed out that since your only contact with the world about you is through your senses, and since all of the knowledge which you have concerning the Universe has come to you through them, if you are to formulate mathematical rules based upon your observations you must begin with the assumption that the things which your senses tell you are true. If you should observe, through a large telescope, the creation of a nova in a remote galaxy, and at the same time observe the eruption of a volcano upon your Earth, you must assume, for the purpose of your mathematics, that the two events are simultaneous. This is an assumption which is difficult to accept because the faculty which we call reason immediately interposes the objection that a separation in Space involves an elapse of time between the events and our perception of it. However, Dr. Einstein points out that if you allow your reason to modify your observations, you will be evolving a concept whose value is based only upon the validity of our reason rather than upon the accuracy of our observations. We must assume that

events which are observed simultaneously occur simultaneously in so far as that. observer is concerned. and that, therefore, the simultaneity of events is a condition which depends entirely upon the position of the observer with respect to those events.

"If we examine this concept carefully, we find that Time follows the same curve of natural law which is apparent in the operation of all the basic factors of nature, and again the radius of that curvature is measured by the quantity C. A simple analogy may serve to make this statement more readily understood.

"Suppose you were to start to-day to build a Space Ship, I will assume that the ship will require one year of your time to build, and that when completed, it will be capable of infinite acceleration. I will assume that a continuous supply of energy is available from an outside source, and that the craft will continue to accelerate so long as this energy acts upon it. During the year which you spend in building the craft, light is being reflected from us into Space, so that an observer with a telescope stationed at some other point in Space could follow the course of its construction. When you have completed the construction of your craft you will enter it and take off for a destination which I will assume to be a planet circling about Alpha or Proxima Centauri, your next nearest suns. about four light years distant. You have a telescope of unlimited power in the rear of the craft pointed toward the Earth which you are leaving. and another telescope at the front, focused upon the planet which is your destination. You will set the field strength for a constant acceleration, and seat yourselves at your telescopes to observe the result. After you have risen a few miles from the surface, you will, for the purpose of furnishing an additional reference point, eject from the craft and its field a cannon ball or other sphere of metal which has been specially painted so that it can readily be observed from any distance with the rid of your unlimited telescopes. Since you had not yet reached escape velocity when the ball was ejected, you will observe that it soon begins to fall back to Earth.

"As you continue to accelerate, you will observe that the kinetic energy differential which you are producing between ourselves and your points of observation is producing exactly the effect upon Time which is predicted by your assumption of the curvature of natural law. Since the distance or degree of separation between yourselves and the Earth is increasing with Time, the energy differential is negative, which means that the natural laws at the observed point will be displaced towards the base or zero line of the sine curve, in so far as our observations are concerned. If you reach a velocity equal to one-half that of light, and then observe a clock on Earth through your telescope, you will see that in ten hours of your time, only five hours have been recorded by the Earth clock. If you observe the test sphere which you ejected during your take off (assuming that it has not yet reached the ground) you will see that it is not falling at the rate predicted by your laws of gravitation, but at a rate only half as great. You will also observe that the sphere is not accelerating at the rate predicted by your laws, nor even at half that rate. Since you yourselves are still accelerating, the observed acceleration of the sphere is diminished by a factor which is proportionate to yours. You must remember that you can only observe events through the light which is emitted or reflected by the objects concerned with those events, and if you yourselves have a motion equal to one-half that velocity in the direction in which the light is moving, then a column or sequence of light impulses which were emitted from the Earth during a five-hour period, would require ten hours to pass your point of observation.

"When the velocity of your craft reaches that of light with respect to the Earth, there will be a negative energy differential, equal to the quantity C, existing between you and your point of observation. You will observe that all natural laws upon the Earth have reached zero value with respect to you. All motion and all changes have ceased. If you observe your test sphere you will see

that gravity is no longer acting upon it, since it has ceased to fall. All laws of motion are in abeyance and the factor which we call Time has ceased to have any significance.

"To make these observations, of course, you would require one of the new telescopes which operate on the retention of vision principle, where the last image to arrive remains upon the viewing screen until a new light image arrives to change it. When you reach the velocity C, no new light will arrive, hence the picture will not change until you change your velocity. With an ordinary telescope the Earth would disappear from vision.

"Since I said at the beginning of this analogy that your craft was capable of unlimited acceleration, and since the assumed force continues to act, your velocity will continue to increase and you will have between yourselves and the Earth, a rate of increase in the degree of separation which is greater than that specified by the quantity C. You can do this from your point of reference although, as will be explained later, you cannot do it from the point of view of an observer upon the Earth. When you have passed through the velocity C, a startling change occurs in your observations. You no longer observe the Earth from the telescope at the rear of the craft. The Earth now appears in the telescope at the front, and you are no longer leaving the Earth, you are now approaching it. You will see a craft which is identical to yours, and which is indeed your own craft, detach itself from you and move back toward Earth ahead of you at a rate which is proportionate to your excess over the velocity C. If we observe the Earth, we discover that all natural laws are operating in reverse. If you observe the test sphere you will see that it is now falling away from the Earth rather than towards it. Gravity between the Earth and the sphere has become negative with respect to your point of reference as have all the natural laws. You observe this through the forward telescope rather than that at the rear, because you are now overtaking the light which had passed you before you had reached the velocity C, and since you are now overtaking it, you encounter first the light which had passed last. All events occur in reverse, just as would the scenes in a motion picture film which is being run backwards.

"If you complete your journey to the planet which is your destination, at an average velocity equal to four times C, you will arrive with an elapsed time of one year as measured by the clocks of your own craft. During the journey, however, you will observe the elapse of five years of time upon the planet which you are approaching, and the elapse of three years of negative time upon the Earth which you are leaving. In other words you will arrive at your destination three years before you left the Earth. If, immediately upon your arrival, you seat yourselves at a telescope of sufficient power to observe the Earth at close range, you will see yourselves going about the daily tasks which you performed two years before you began to build the Space craft in which you made the journey. If you then focus the telescope upon the proper point in Space you will see yourselves in your Space craft. flying backwards toward the Earth.

"You are now in a position from which you can observe the sine curve nature of all natural law, and to measure precisely the radius of the curvature. If you observe the Earth, you see that Time there is positive. That is, it is moving in the direction which we consider normal. Since there is no significant energy differential, the Time rate is essentially the same, but because of the degree of spatial separation there will be a displacement along the Time curve, between the observer and the point which he is observing. According to the theory of the curvature of natural law, this displacement should be equal to D divided by C, where D is the distance and C is our basic factor. In the case of your present observation the distance is equal to 4C years, which if divided by C will equal 4 years, which is precisely the degree of displacement which you would observe. If you now turn your attention to the Space craft, you find that you are observing it through an energy differential which exceeds the quantity C and therefore the craft is within the negative portion of the curve, and all natural laws will be operating in reverse at that point. You are now in a unique

position, in that you now can, from a single point in Time or at least from a single point in the only dimension of Time of which you are conscious, observe yourselves occupying three rather widely separated positions in Space. First, your position at the telescope as the observer. At this point Time is positive. Second, your position on the surface of the Earth. Here Time is also positive but has a negative displacement upon the Time curve which is equal to four years. Third, your position in the Space craft. Here Time is negative, as demonstrated by the fact that you observe it flying backwards toward the Earth, and all actions taking place within it occur in reverse order. This is, of course, due to the fact that the craft had a velocity greater than that of C and so was constantly leaving behind the light which was emitted or reflected from it. As you observe the craft from your new reference point, the last light which it emitted arrives first.

"If you continue to observe for several years, you will eventually see yourselves build the craft and take off into Space. At the same time you can see yourselves in the same craft hurtling backward through Space toward the inevitable meeting point where the past and the future join to become the present. Since you are observing yourselves simultaneously occupying three different positions in Space, we can readily see that you are forced to a concept of Time which includes more than one dimension. If you continue to observe the two craft, you will see that the one which is moving away from you is constantly slowing down, while the one coming toward you from the Earth is accelerating. At the instant in which the velocity of the receding craft reaches zero, the approaching craft will reach it, coincide with it, and both craft will disappear completely from your view. Your lateral excursion into Time has completed its curve and you have returned to the starting point of your unidimensional concept.

"There is only one thing left for you to do. You immediately leap into your Space craft and begin your return journey to Earth. As before, you achieve an average or mean velocity equal to 4C. You land your craft near the observatory of an astronomer who is a friend of yours, and rush in to tell him of your return. You find him seated at his telescope observing your landing upon the planet which you had set out to visit. When you inform him that you achieved an average velocity of 4C, his reply is that this is impossible since the laws of relativity clearly state that no object can achieve a velocity in excess of C (with respect to a given reference point). He will also point out that he has been observing you constantly since your take off from the Earth and that only now, to-day, five years later, were you observed to have reached your destination. Since the journey required five years of Earth time, our average velocity was only four fifths that of light.

"According to the primary postulate of relativity, that for mathematical purposes we must accept the results of our observations as valid, the astronomer is perfectly correct in his statement that you did not, and could not have exceeded the velocity C. The mere fact that you may have returned, be seated at his side. and may perhaps be assisting him in his work, does not in any way affect the validity of his observations nor the mathematics of relativity which he applies thereto. He can only state that your arrival upon the distant planet, and the moment of your return to Earth were in fact simultaneous.

"We can see that, even if your energy level had been so close to infinite that the outward trip had required only one second, if during the one-second trip you had emitted enough light to make observation possible. the astronomer upon the Earth would note that the trip required four years and one second, and so would have undeniable proof of the mathematics which assume that only with infinite energy may the velocity C be achieved.

A General Summing-up

I HAVE DISCUSSED with you briefly, Dan, a number of these aspects of the principle of relativity which have created what I have described as thought blocks in the minds of many Earthly students, scientists, and engineers. I have pointed out that these thought blocks are not actually inherent in the mathematics of relativity, but are obstacles created by the arbitrary interpretations which Earth men have placed upon those mathematics. Yet these are the illusory obstacles which have prevented you from making the one approach to Space travel which is certain of ultimate success. You Earth men must come to realise that the natural laws are not enemies to be destroyed, neutralised, or overcome, but are friends who will, if you only make the effort to understand them, produce for you any end which you may desire. You must realise that the rules of limitation found in your mathematical approach to nature, are limitations only of your own perception and consciousness, and have no absolute significance in so far as nature itself is concerned.

"Some of the more dogmatic of your scientists still assert that you can never hope to reach even the nearest of our neighbouring stars because even with infinite energy the trip would require many years. I have shown you that while this statement may be perfectly correct with respect to a reference point upon the Earth, if you leave the surface of the Earth, your reference point will go along with you, and the 'limitations of relativity' will always precede you at a distance equal to the quantity C.

You need not fear that you will ever overtake or be hampered in any way by those limitations.

"The concept of the sine curve nature of physical law is not at all new upon this Earth, although the present civilisation has not, as yet, achieved any great understanding of this concept which has enabled previous civilisations to accomplish, in their comparatively brief periods of development, many things which your present vaunted science has not yet been able to duplicate."

"Exactly," commented A-Lan. " The inherently aggressive nature of Man leads him to attack, instinctively, any obstacle which lie may find in his path. The prospector in the mountains, who stubs his toe on a pebble and falls upon his face, is much more likely to arise and instantly hurl the offending pebble into the canyon, than he is to examine it carefully to see whether it may contain the gold which he is seeking. The same situation exists in your science of to-day. Whenever you come upon a natural law which appears to be an obstacle to the particular end for which you are striving, your automatic reaction is to seek means to destroy, to neutralise, or to overcome that law. The result is that your present science follows an almost incredibly complex pattern of basic conflicts. Natural laws are pitted against each other, or a greater degree of one law is applied in opposition to a lesser degree of the same law. You seldom pause to consider the fact that, because of the dual nature of all physical law, if one aspect or pole of the law is a hindrance to your end, the other pole or aspect of the same law will provide the assistance which you require.

"Having resolved the misinterpretation of your mathematics the job of the theoretical physicist is done. The next move is up to the practising physicist and to the engineer." A-Lan paused. "Well. Dan," he went on, "I think that is about as much new knowledge as even you could assimilate in one day."

"Thank you very much." said fry. his mind in a whirl.

"Good bye. Dan. Don't go away from here for a while as I shall be around again soon."

Daniel Fry listened, but A-Lan's voice did not come again. He looked at the trees around him, all bedecked for spring and marvelled at what he had been told. He thought of all the things A-Lan had said to him, about gravity, the curvature of natural law, and most amazing of all, about Time.

He held his head in his hands-he had too much amazing new knowledge there and knew that he would forget A-Lan's vital information if he did not write it down. He had been sitting on the soft turf while speaking to A-Lan, but now sprang up and ran back to his house as fast as he could. He fetched paper, sat down, and began to write ....

The Third Meeting

TRUE TO HIS promise, on 28 April, 1954, A-Lan established direct contact with Daniel Fry for the third time, only a week after the second meeting. There was a sense of urgency in this contact which had not been present during their previous meetings. It was also the first time that it was made clear to Fry that he had a personal duty and responsibility in the effort which A-Lan and his friends are making to alter the natural flow of events, and thus avert the holocaust which is otherwise inevitable. Fry was still at his place in the Oregon woods, in the hope of making this contact, because he wanted guidance as to what use, if any, he should make of the information he already had.

Fry had been absolutely alone for three days when, early in the evening of the third day, A-Lan's voice came to him in its usual abrupt fashion. "Well, Dan, how much longer are you going to hide your light under a bushel?"

In spite of the fact that he had come eight hundred miles and had been waiting for seven days in the hope of making this contact, Daniel Fry was just as startled as though he had never heard A-Lan's voice before. He looked quickly around the room half expecting to see someone standing in the shadows, although his reason told him that there could be no one there. Finally he recovered enough to make an answer, but all he could say was, "What do you mean?"

"You know what I mean," A-Lan replied. "In your great book of wisdom and philosophy which you call the Bible, it is stated that when a man has lighted a candle, he does not place it under a bushel, but holds it forth that all men may be guided by the light. We have expended considerable time and patience in the effort to light a few candles among the races of your planet. It has been our hope that the light of these candles might grow in brilliance until it exposed the terrible abyss toward which the peoples of your world are so blindly rushing.

"We have given you information which is both of interest and of value to your people. Why do you keep it to yourself?"

"But what can I do?" demanded Fry. "I am unknown. How can I reach the public, and who would listen if I could?"

"Those who are not blind to truth will recognise the value of the message, regardless of who the messenger may be. Write what you have learned from us in a book. You have already met the man who will publish it. Tell the story through your newspapers, your radio and television stations, and if necessary, shout it from the house-tops, but let the people know."

"You don't realise what you are asking," Fry said. "If I adopt this course a few people may listen, but many more will not. There are too many people in this world who are afraid of the truth, and who are more afraid of anything which might change the existing order of things. If I attempt to

make public the information which you have given me, it will only mean that I will be scorned and ridiculed. I will be called a liar by some, a fool by others, and a charlatan by still others. If I give a statement to our newspapers, they will either ignore it entirely, or they will print a comic distorted version which will make me appear stupid and ridiculous."

A-Lan's voice took on the patient but slightly strained tone of a teacher who is attempting to explain a simple fact to a somewhat backward student. "Of course you will be ridiculed. Ridicule is the barrier which the ignorant erect between themselves and any truth which frightens or disturbs them. Can you name any man of your planet who has ever accomplished anything of great value to your people, who was not ridiculed and scorned by some? It is the price which is exacted from every man who is as much as one step in advance of his contemporaries. There is a saying in the records of the previous civilisation of your world which I believe should be on the frontispiece of every book of philosophy. 'It is easier to ridicule than to investigate, but it is not as profitable.' Yes, you will be called a liar by some and a fool by others. If you seek or accept any financial assistance, however small, you will immediately be accused of commercialism, and yet the expenditure of at least some money is a prerequisite among your people to the accomplishment of almost anything. There are many problems which you will have to face, but remember that they are by no means peculiar to your position. They have been faced and met by every individual who has ever offered his services and his knowledge to his neighbours, in the attempt to advance the culture of the race. Remember also that you will have friends, more friends than you ever dreamed of. While it is true, as you say, that there are too many persons who fear for anything which might change their way of life. there are others, more than you think. who sense the critical position of your civilisation, and are searching diligently for the remedy. They will look before they laugh, and for every one who looks, you will have another friend.

"Don't forget what I have told you about the power of thought. When you have friends, you are never alone no matter where you may be. Every mind that is for you will be with you, and will give you added courage and ability."

"I hope so," said Fry. "I have a feeling that I am going to need plenty of both.

"It has been almost four years since you first made contact with me." Fry went on. "In a few more months you should be completely adapted to our environment. Why don't you simply set your craft down on the White House lawn some morning, ask for world-wide communication facilities, and give the whole world your message at once?"

"This 'simple solution ' is only wishful thinking on your part," A-Lan replied. "We have discussed this before, and if you will think a little, you will see that there are many reasons, both general and specific, why such a course would not be successful

"There are three types of branches of science which are necessary for the proper development of mankind: the Spiritual Science, the Social Science, and the Physical or Material Science. The spiritual and social sciences must come first. There can be no development of the material science unless there first exists a foundation of the spiritual and social sciences. You can prove this to yourself by considering the difference between Man and the animals. The animal has no spiritual or social science and consequently has never developed a material science. A few of your insects such as the ant and the bee have developed a rudimentary form of social science to the extent that they are able to live together in large numbers, work together for their mutual welfare, and have a form of discipline which is common to all. As a result of this they have also developed a very limited material science, in that they erect structures and store food against a future time of need. The fact, however, that they have no spiritual science has proved an absolute bar to further development with the result that they have not advanced a single step in thousands of years.

"Man, on the other hand, has, from the very beginning of his development, sensed the fact that there is a supreme power and intelligence which pervades and controls all nature. Man's attitude toward this power has varied from fear and resentment to reverence and love, but always he has had the desire to learn more of the nature of this power. Thus the spiritual science had its beginning in the very dawn of human intelligence. With the realisation that man could improve the conditions of his life only by co-operation, came the first tribal gatherings which were the beginning of the social science.

"From the foundation provided by these two sciences the superstructure of the material science began to emerge, and here begins the problem. The development of the material science, being constantly stimulated by the ever-increasing needs and desires of the body, progresses normally according to the square of time. This too, you can prove to yourself if you consider the inventions and material developments which have taken place within the last thirty of your years, compare them with the development of the previous hundred years and then compare that in turn with the previous thousand years. You will see at once that the development of the material science takes place at a rate which is constantly accelerating. The spiritual and social sciences. on the other hand, progress normally, only directly with time, and even this rate of progress is not always maintained.

"You now have the problem of a huge and massive structure, growing at an ever increasing rate, standing upon, and supported only by a foundation which is growing at a much smaller rate. It is obvious that unless some means are found to stimulate greatly the growth of the foundation, a time will inevitably come when the structure will collapse upon that foundation, bringing ruin and destruction to both. This has occurred before upon your Earth, and your civilisation has now entered the stage where it is likely to occur again.

"We are now essentially independent of planets. Some of our craft are very large, judged by your standards. They are many times the size of your largest ships. We are able to produce all of the necessities and comforts of our physical lives within these craft and since we have solved the problem of energy we have no personal need to land upon any of the planets, except occasionally to obtain raw material for new construction.

"The satisfaction of our own physical needs now requires only little time and effort. consequently we are able to devote much of our thought and energy to the assistance of those races which have not yet passed the critical point in their development."